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# JOURNAL OF THE UNITED STATES ARTILLERY

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*Photograph by Boston Photo News Company*

1229

U. S. S. WYOMING ON TRIAL COURSE OFF ROCKLAND, MAINE

Displacement, 26,000 tons; length (waterline), 550 feet; beam, 93½ feet; maximum draft, 28½ feet. Armament: 12—12-inch, 50 cal; 21 5-inch, 50 cal; 4—3-pounders; etc. Torpedo tubes: 2—21-inch, submerged. Armor: 11-inch belt (amidships), 5-inch belt (ends); 12-inch turrets; 11-inch turret bases; 6½-inch battery. Parsons turbine

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# JOURNAL

OF THE

## UNITED STATES ARTILLERY

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*“La guerre est un métier pour les ignorans  
et une Science pour les habiles gens.”*

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THE JOURNAL FROM MARCH, 1902, TO SEP-  
TEMBER, 1907

BY MAJOR ANDREW HERO, JR., COAST ARTILLERY CORPS

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On the promotion of Captain Wisser to major and his transfer to a new station, necessitating his relief as editor, the JOURNAL entered upon a new phase of its career. Captain E. M. Weaver, Artillery Corps, was temporarily designated as editor; and, thanks to propositions submitted by him and subsequently approved by the War Department, the JOURNAL attained a stronger position than ever before. It was placed under the direction of the Artillery Board, of which the JOURNAL's editor, selected and designated by the War Department, was made a member, the other members being the Commandant of the Artillery School, the heads of departments in the School, and the two field officers on duty at the post, all of whom took an active interest in the JOURNAL and its work. Thus the JOURNAL received fuller official recognition, and, due to the character of the Board, a degree of permanence in its management that had not necessarily characterized it before.

I was on duty at the Military Academy when, on March 7, 1902, I received information that I had been recommended by the Chief of Artillery as editor. The detail was most acceptable to me. I had been associated with the editorial



management under Major Wiser, having been assistant editor after the relief of Lieutenant Blakey, and had had experience in all details of the publication during the latter part of 1899. It was with pleasant anticipations, therefore, of congenial and interesting work that I reported for duty with the JOURNAL July 1st, 1902.

And I was not disappointed, for we were then at about the beginning of a period of reorganization and new development in the coast artillery service. The Act of 1901 had brought in many new officers eager for artillery knowledge. Bright and progressive ideas were not lacking. The drill regulations were being formulated, the fire control system developed, mechanical devices and other equipment were being devised and adopted, and the methods of coast artillery instruction placed upon a systematic basis. The field artillery also was not without its new problems, due to the adoption of the new material, model 1902.

Thanks to the ability and energy of former editors, the JOURNAL had come to be an important source of professional information to the artillery service at large. And, in responding to the demands of the School, in which it was required about this time as a reference book by the Department of Artillery, it exerted a distinctly educational influence, enabling artillery officers to keep posted in artillery thought and methods current both at home and abroad.

My aim was to improve the JOURNAL as much as possible, to make it appeal to the constantly growing body of subscribers, and to continue that policy which, in the words of its founders, was, "as outlined by the needs of a progressive and enterprising corps: to keep within its legitimate field; always in the foreground of artillery advancement; to inform its readers of what is actually an accomplishment; and above all, to lead them on to the problems of the future."

Results were gratifying: the number of subscribers rapidly increased; and especially pleasing was the marked increase in our foreign subscribers. The encouragement and support thus received lent zest to what at times was arduous work. But there was always a bright side, and my interest never lagged. In January, 1905, the JOURNAL was able to appear in entirely new dress, with larger and better type and better paper. This, with an increase in the number of illustrations and some minor improvements in arrangement, gave it a pleasing and handsome appearance.

In the latter part of 1905 the Artillery Board was reorganized and separated from the School, but the editor of the JOURNAL remained a member of the former Board. Subsequently, in 1906, upon a reorganization of the Artillery Board, the editor was relieved from duty therewith and the JOURNAL was put directly under the supervision of the School Board, Coast Artillery School, per G. O. 181, W. D. 1906, where it naturally belongs.

I was relieved from duty as editor on July 9, 1907, having been five years on this duty; but, my successor not reporting for duty until September, I continued in office until September 20, 1907. The recollection of those five years during which I had the management of the JOURNAL, brings vividly to mind the absorbing interest of the work, the natural feeling of pleasure and compensation for results achieved in spite of some drawbacks and trials, and the sympathetic encouragement accorded me by those interested in the JOURNAL's welfare. The JOURNAL always has had, and always will have, a warm spot in my affections, and no one can wish it more heartily increasing and long-continued success.

# THE JOURNAL OF THE U. S. ARTILLERY FROM 1907 TO 1912

BY MAJOR THOMAS W. WINSTON, COAST ARTILLERY CORPS

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More than a year ago, when this series of papers was first projected, the writer was occupying the editorial chair and thought that his contribution would be but a few lines to bring the history of the JOURNAL down to date. When he comes to complete his effort and turn the results over to his successor, his status has changed, and he finds himself one of the "past presidents," as it were. He therefore feels in a position to say many things in regard to our JOURNAL which may not be known, or entirely understood, by some of our officers. This paper has, as a result, developed into a sort of confidential, heart-to-heart statement, intended primarily for officers of our own corps and written, mostly under rather disadvantageous circumstances, in the hope that with better understanding will develop greater enthusiasm for the JOURNAL, greater interest in coast artillery work, and heartier *esprit de corps*.

The JOURNAL of the United States Artillery is the only periodical which is published solely for coast artillery,—that is, for the work of coast artillery, as at present assigned by our Government. For while in many countries are journals similar in name to ours in which are to be found articles on subjects akin to coast artillery, yet all are primarily intended for the advancement of field artillery. The positions, geographical and political, of most of the other important countries, are such that their field armies are of first importance to them and their coast defense of secondary interest; and that fact is, of course, reflected in their technical literature,—in which is to be found usually little or nothing relating to coast, and a great deal of excellent material on field, artillery work. Our JOURNAL, therefore, occupies an unique position, and we are obliged to depend upon ourselves for most of our matter relating strictly to coast artillery.

This suggests some of the difficulties which had to be met by those who founded the JOURNAL twenty years ago and carried it to success; and it cannot fail to remind one who has at any time been charged with satisfying the JOURNAL's voracious appetite, of the difficulties met with in gathering together the requisite amount of material every sixty days. For while there should be no difficulty in providing double the amount that could be used, without lowering the standard of quality, yet there is difficulty; and it seems that the reasons therefor are two in number. The first and most to be regretted is that officers do not all look upon the JOURNAL as an institution in which they are partners, for whose support they are partially responsible, and for whose standard of excellence each one is as much accountable as any other. If we of the coast artillery had no technical publication, no one would think of denying the absolute necessity of establishing one; and since we have such a publication, it should be recognized as incumbent upon everyone in the corps to do his share, not only in keeping up its standard, but in raising that standard still higher. We should remember, too, that it is not merely the exhaustive dissertation or the learned mathematical discussion which makes the JOURNAL valuable to its readers, but the little things, short notes, or paragraphs, telling of some method of accomplishing an object in our work, or describing some device used in the writer's company,—any such will assist some one at some time and help to make the JOURNAL of maximum usefulness to its readers.

The second difficulty in the way of providing an abundance of material for the JOURNAL, lies in natural modesty and diffidence, many persons hesitating to offer for publication anything, however valuable, for fear of being accused of a desire to "rush into print," as the phrase is. But it is to be hoped that this feeling will disappear and that the time will soon come when everyone who has done anything worthy of description, or who can furnish any ideas which will be of use to his fellow officers, will feel it his duty to submit an account of them for publication in the JOURNAL.

By the year 1907, the pioneer work in the making of the JOURNAL of the United States Artillery had been largely completed. Originally a publication entirely at the mercy of an administration of the Artillery School, which might happen to be hostile to it, or which might not appreciate its possibilities, it had been given a sufficiently official character to protect it

from any such interference. For the first ten years, its editor performed his onerous duties, as such, in addition to a large amount of routine work, his work on the JOURNAL being purely voluntary. Since then, an officer has been detailed to edit the JOURNAL, though performing a greater or less amount of other duty. Thus, when, on Sept. 19th, 1907, the writer assumed charge of the editorial sanctum, he found plain sailing on a course unmistakably indicated by the policy of his predecessors and by the evident needs of the coast artillery. It is not meant to suggest that there was dearth of work—let there be no mistake about that. In fact, one of the interesting features of the work in the JOURNAL office lies in the fact that, when the absolutely necessary work is done, there is an endless variety of new work which can be taken up for the benefit of the JOURNAL and its patrons. Unfortunately, the amount of work which can be done by the editor and his assistants is limited, and the number of projects which can be carried out is correspondingly restricted. The only difficulties of consequence which have been encountered during the past five years have resulted from the necessity of limiting the lines of action of the Journal in order to prevent overwork on the part of the office force.

Early in 1908, the Chief of Coast Artillery detailed a master gunner as an assistant to the editor. This has been of the greatest possible advantage. It has enabled the editor to devote his attention to the more important features of the work, leaving all routine matters, such as book-keeping, records of correspondence and most of the proof-reading, to his assistant. It would be unfair not to mention, in this connection, the very excellent services of Master Gunner Claude L. Kishler, Coast Artillery Corps, who has filled this detail for the past four and a half years.

At about the same time, a type-setting machine was purchased by the JOURNAL—a most fortunate thing, as the possible output of the printing office was, with its assistance, greatly increased. One of our old printers was sent to the school conducted by the manufacturers of the machine, to learn to handle it. Since then three other men have been sent to the school; and it is intended always to keep two competent men in our office force.

Great effort has been made to improve the typography and appearance of the JOURNAL. A new press was purchased a year ago and a man was sent away to learn the

refinements of the pressman's work. A standard grade of paper has been adopted, and this has greatly improved the appearance of the JOURNAL. Of course, each of these steps has required money and could be undertaken only as financial considerations permitted.

In 1908 the Coast Artillery School and the School of Submarine Defense were consolidated, and the school as at present organized resulted. Since then, the JOURNAL has been used to a constantly increasing extent in the school work and is recognized as one of our most important educational features. This has increased the scope of the demands upon the JOURNAL and has made it even a more important institution than it was previously. Until 1909, the JOURNAL office was in the old library building; but now it is housed in handsome, commodious offices in the new Coast Artillery School Library building. Having worked in the old library (for which, though, the writer confesses an abiding affection), it is a real pleasure to enjoy the cleanliness, convenience, and architectural beauty of the new quarters.

The writer, while editor of the JOURNAL, endeavored to carry out his conception of its proper functions. He understood these to include assisting anyone in the Coast Artillery Corps, whether a subscriber or not, to acquire information along professional lines, at any time and in any way possible. This was thought to be the correct course, both on the ground of courtesy and because it was thought to be more in the interest of the Coast Artillery Corps in general.

In this way the JOURNAL office is, in a modest fashion, a bureau of information for the coast artillery service. As the editor is also librarian of the Coast Artillery School Library, he is in a position to furnish information which might not, otherwise, be available to him. In fact, it is a little hard always to differentiate between the duties of the two positions. But, whether acting as the one or the other makes no difference, as long as the object is attained—that of justifying the existence of the JOURNAL and making it of maximum usefulness.

Nor is the field of action of the JOURNAL confined to our own service. Every opportunity is embraced of furnishing information to persons in foreign countries. Our ability to answer such questions is limited, in regard to our own equipment, by considerations of policy; but this policy, as now determined by the Chief of Coast Artillery, is a broad one, and, moreover, the questions asked do not ordinarily relate to sub-

jects the discussion of which would be contrary to good policy. Following the line of action suggested, which is that which has been pursued by the Journal's management since its foundation, very cordial relations have been established between us and our fellow-officers of the coast artillery in several foreign countries.

As suggested above, it is thought that some officers do not really appreciate the objects and the functions of the JOURNAL. During the past five years the editor has received many letters from coast artillery officers which indicated that they felt no sense of proprietorship in the JOURNAL and that they had no feeling of interest in its welfare, beyond what they felt in the welfare of any other magazine, or periodical. Surely, no one who has read the articles in the September-October, 1912, issue of the Journal can fail to feel the inspiration of the work of the founders of the JOURNAL. They were actuated by pure interest in their profession, by *esprit de corps* of the best sort. There was no way then for any officer, one new to the service especially, to learn anything about his profession. There were works in plenty describing the old artillery, but none which told anything of the new which was then in process of evolution. We were far behind foreign nations in everything relating to coast defense, and could learn much from them, especially by consulting their current periodical literature. And one object of the JOURNAL was to bring the mass of information contained in those periodicals within the reach of our officers; for no one officer could subscribe to all, or could read all, if he did; but by reprinting in the JOURNAL what was best in them, either in abstract, or *in extenso*, their store of knowledge and information was made available for the use of all our officers.

It was most important that during the evolution of our system of coast defense and its auxiliaries, full and free discussion should be encouraged on all questions relating thereto. And at that time our coast artillery officers were more scattered than they are now, so there was no way in which discussion could be had until the JOURNAL was founded. It afforded a medium through which any important question could be thoroughly threshed out before the whole of the artillery: anyone could speak his mind and have his hearing with certainty of audience. But the most important result attained by the originators of the JOURNAL project has been in the maintenance of *esprit de corps*. For since 1892, the Coast Artillery has lost its regimental organization, and with it the binding force of



the old regimental sentiment, and it has been largely increased, so that it has had to assimilate a numerous body of new officers. But though we have come through difficult times, the high standards which prevail, the conscientiousness and the energy which pervade all our work show how well old traditions have been preserved. In this direction, the JOURNAL has been of greatest use.

Every profession has its technical journal. The engineering profession, for example, supports a legion of periodicals, each branch having its own organ, while there are besides many commercial magazines which treat of the profession, or some of its branches. Every engineer subscribes, as a matter of course, to some of those in his line. By this means he keeps up with the latest thought of the most progressive men. The founders of the JOURNAL enabled officers of our corps to keep up, in the same way, with the latest progress in everything relating to coast artillery.

In this connection, there is a fact which seems worthy of consideration,—that, whereas almost every man who is commissioned in the Coast Artillery Corps from civil life, or from the ranks, subscribes to the JOURNAL within a short time after joining, our West Point graduates do not seem to feel the same need of the assistance of the technical organ of their branch of the service. It is difficult to understand why this should be. The graduate of the Military Academy has had but little instruction in coast artillery work. This is matter of course, since he has had only what is considered essential for every cadet, to whatever branch he may be assigned at graduation. It is not meant to disparage the course of instruction in coast artillery at the Military Academy—far from it. It might be said here that the Coast Artillery Corps owes a debt of gratitude to one of its former members, now of the Field Artillery, to whose persistent efforts the complete fire-control installation at West Point is due.

The graduate of any other technical school (to which class most of our other second lieutenants belong) on the other hand, has usually had no experience whatever with coast artillery. But while at college, he has been impressed with the desirability, or rather, the imperative necessity, of allying himself with his profession as closely as possible, and with the fact that there is no more important step in this direction than that of subscribing to one or more of its technical journals. Are these facts impressed upon the minds of cadets, as they



are upon the minds of students at other technical schools? If not, should they not be? It would seem that they should.

The JOURNAL has a wide circulation. Upon its mailing list, besides our own officers (of the regular forces and the reserves) are many in other branches of our own service, especially in the Ordnance Department and in the Engineer Corps, nearly all officers of the former being upon our list. Some naval and marine corps officers also are among our readers.

The foreign mailing list contains the names of many officers in the services of other governments. These are especially numerous in the British Royal Artillery. Some of these are stationed in the home country, while others are in the various dominions and colonies of the British Empire. One of the latter, recently transferred from a home station, in subscribing to the JOURNAL, said, "I am doing a tour of foreign service here and no longer have access to any library which takes your JOURNAL, which I find indispensable for keeping up with the rapid progress of Artillery Science." The JOURNAL is surely pardonable for smiling in pleased satisfaction at such a message from one of its old friends. There are also some officers of the local forces of the various dominions who are among our subscribers. The European countries are represented by officers of artillery and by their great ordnance manufacturing establishments. Our friends in Japan are numerous, as are they also in Mexico and the South American republics. The difference in language, doubtless, prevents a still greater number of readers in the latter countries.

One of the JOURNAL's valuable features is its list of exchanges. These number more than one hundred and fifty periodicals, comprising all the military journals published in this country and many from foreign countries; also, an excellent selection from engineering periodicals the world over; the proceedings of many learned societies of various countries; magazines on historical lines dealing principally with this country. A list of these exchanges is in each issue of our Index to Current Military Literature.

This index is considered by those who use it as one of the most valuable features of the work of the JOURNAL, although less understood, probably, by the generality of JOURNAL readers and more maligned than any other. This would seem to result from lack of understanding of it and its possibilities, now and in the future. Perhaps a short dissertation upon the index may not be out of place here.

Every branch of human action has its current literature, in which are presented the latest thought and the latest results of research in that line. After a time the matter thus published finds its way into the permanent literature of the science or art to which it belongs. But in the meantime, he who uses it would have to search through all the periodicals on the subject to keep himself informed, or to avail himself at any time of what has been done or written upon any subject. This is manifestly impossible for any one who is busy. Hence, in each line, someone makes an index of the articles which appear during a given period in that line, thus making available, with little labor for the one interested, the latest data and thought upon the subject in which he wishes information. In this way, progress in military matters is registered in a mass of literature too extensive for any one person to read or digest. To make it readily available, the founders of the JOURNAL inaugurated the Index to Current Military Literature. It appeared originally as a part of the JOURNAL, but for some years it has been issued as a supplement. To make reference still easier, for the past year or two the three issues of the index, concurrent with one volume of the JOURNAL, are cumulated in the last number. To consult the index for a given year, one must look in two, instead of in six, lists. The suggestion is sometimes made that the issue of the index be discontinued, and the great amount of time and labor involved in its preparation be devoted to other work of more general use. Also, it is said that the periodicals referred to are not readily available for reference by officers. It was suggested not long since, by one of our most capable officers, that it might perhaps be well to substitute for the index short abstracts of articles of importance, using the same space as now devoted to the index. These suggestions were given due consideration, but the conclusion reached that to discontinue the index would be to cut off one of the JOURNAL's most valuable permanent functions. It is true that most officers do not have at hand all the periodicals quoted in the index, but all have some of them. Those stationed near one of our large cities can find the greater part of them in the libraries of the city or of technical societies. If one is looking up a particular subject, a letter to the editor of the JOURNAL, telling the sort of information wanted and mentioning the magazines referred to in the index, has always been promptly and gladly answered with information as to the usefulness of the articles mentioned for the desired purpose, and

with the loan of the magazine, if the article was deemed useful, and was not elsewhere obtainable. The usual library rule that the latest issue of a periodical in the library can not be sent out, will not often interfere with the use suggested. Where the latest issue is wanted and delay would be very objectionable, an exception to this rule can generally be made. Abstracts of many articles, as suggested, would often be useful. Yet, by printing the most important articles complete in our "Professional Notes" and mentioning all of any importance in the index, it is thought the objects of the JOURNAL are more completely met than they would be by the other method.

That there is a great deal of labor involved in the preparation of each index will be evident to anyone giving the subject a moment's consideration. The exchanges which are consulted comprise,

- 1 daily
- 1 semi-weekly
- 28 weeklies
- 5 fortnightlies
- 6 semi-monthlies
- 91 monthlies
- 13 bimonthlies
- 38 quarterlies and less frequent publications.

These being in ten different languages, when it is considered that each issue must be more or less carefully read, an idea of the labor involved is gotten. During the past five years, the editor has found it impossible to do all this work himself, from lack of time in part, and in part from lack of familiarity with the languages included; so he has been ably assisted by many officers, who have given freely of their time and talents for the benefit of the JOURNAL and of their profession.

In addition to the publication of the bi-monthly JOURNAL and Index to Current Military Literature, the management of the JOURNAL has other activities. The "Gunners' Instruction" pamphlet for gun companies, which has been issued annually by the JOURNAL for some years, is one of these. The original pamphlet was compiled and used in his company by Captain (now Major) William Chamberlaine, Coast Artillery Corps, when stationed at Fort Monroe several years ago, and one or two editions were printed by the JOURNAL prior to the time covered by this paper. Since September, 1907, an edition has been issued each year. The first one was printed by a commercial press, but since then our increased facilities have

enabled us to handle them. Each year suggestions have been asked for from officers who have used the pamphlet, looking to its improvement in the next edition. As many as possible of these suggestions have been carried out. Two extremes have to be avoided; that is, the pamphlet must not be restricted so closely as to make it a parrot-like preparation for examination. Neither can it be made a complete work on ordnance and gunnery. The idea has always been to steer a middle course between these two extremes. In 1911 the experiment was tried of issuing a separate pamphlet for each caliber—the 12-, 10-, 8-, and 6-inch guns and the 12-inch mortar. This plan has worked very well apparently. The fact that nearly ten thousand copies were sold would seem to justify their issue.

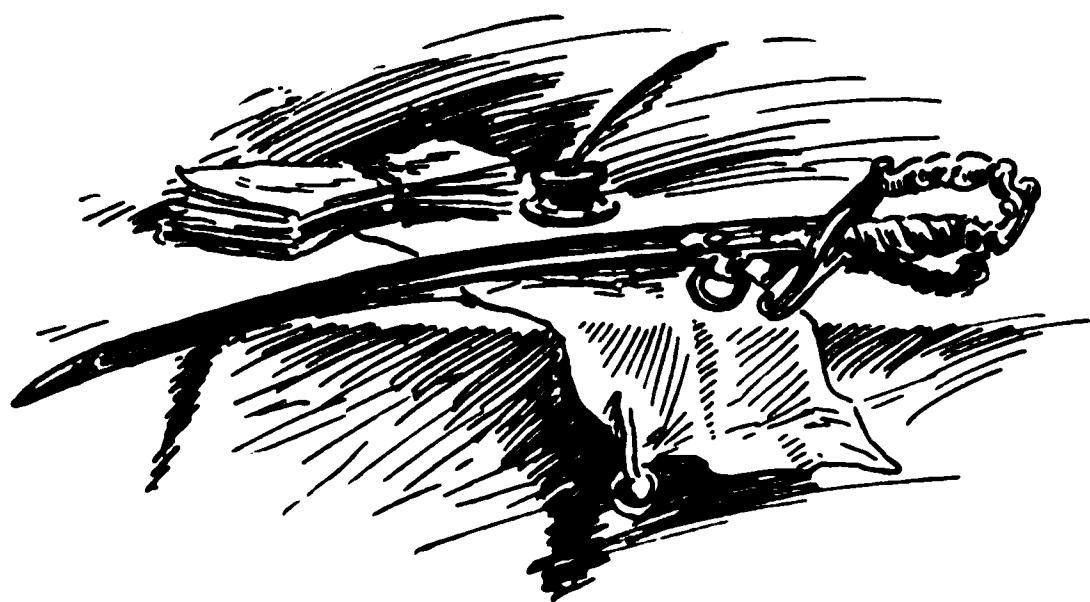
For the past three years a similar pamphlet for mine companies has been issued. It was first used by Captain (now Major) Arthur S. Conklin, Coast Artillery Corps, in his company, having been compiled by him from various sources. It has proved useful, the demand for it being about proportional to that for the pamphlet for gun companies.

The margin of profit for the JOURNAL, upon these pamphlets, is so small that the total gain by their issue is not commensurate with the labor involved,—the return being largely in the consciousness of filling a need of the service.

There is no force more potent for good in any sort of organization than a high *esprit de corps*. The Infantry, Cavalry and Field Artillery have their regimental organizations which assist to create and preserve such a spirit among their officers. In the Coast Artillery, we have had, for the past eleven years, no such bond. The corps is so large that it is difficult to create the feeling of loyalty to it which is so essential to best results. Each of the other branches of the service has, also, its association, which, in various ways, promotes this sentiment. We have not this help. It has seemed to the writer that we should form a Coast Artillery Association, with headquarters at Fort Monroe and patterned after the associations of the other arms of the service. The continued interest of our retired officers, many of them mentally and physically in their prime, would be a valuable asset for us. Now there is but the most nebulous sort of a bond to keep them with us. Usually, as soon as an officer is placed upon the retired list, he discontinues his subscription to the JOURNAL, much as he would stop the "Poultry Journal," if he should sell his stock of fowls. If an association

were formed, most, if not all, of our officers would join it as a matter of course. They would then receive the JOURNAL, without the formality of subscribing. They would, in all probability, retain membership in the association after retiring and would receive and read the JOURNAL, preserving their interest in their chosen profession throughout their lives. The idea is certainly worthy of consideration and it is hoped that it may be fully and freely discussed.

During the five years from 1907 to 1912, the writer spent the greater part of his time upon the JOURNAL OF THE UNITED STATES ARTILLERY. The work was not always easy;—at times, in fact, it was exceedingly discouraging. Yet, withal, he is fully repaid for his labor, if it has contributed to advance the JOURNAL to a place of greater merit and to greater usefulness; and if this sketch of the Journal and its recent progress is productive of a better understanding of it and its objects, the purpose of the writer will have been fully attained.



# DEVELOPMENT OF THE SUBMARINE MINE IN THE UNITED STATES SERVICE

BY LIEUT. COLONEL RICHMOND P. DAVIS, COAST ARTILLERY CORPS

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This article is devoted principally to a brief history of the development of the submarine mine in the United States service, but there is added a short digression on automobile torpedoes in harbor defense, with an appendix showing the results of the use of mines in the Russo-Japanese War.

The early history of the submarine mine will be found to consist, in the main, of numerous accounts, more or less extravagant, of the effects produced by the explosion of a charge of gun powder.

Up to the time of our Civil War mines were more or less considered as infernal machines, and in some quarters this is not now an exceptional view; but so much use was made in that war, especially by the Confederates, of this type of weapon, and so great were the results, that the mine became an accepted element of harbor defense.

The two general classes of submarine mines are controllable and non-controllable. In the Civil War there were practically none of the former type, but since that time the controllable mine has been developed to a high stage of efficiency.

From the inception of the submarine mine the question of secrecy has been a predominating one, and the development and growth of an efficient mine service has been delayed by this bugaboo in practically all countries which have given the subject serious consideration.

With reference to the British system (which I may add has been discontinued for reasons applicable to English policy alone) Sleeman says in effect:

“The unfortunate belief engendered in most officers of torpedo corps that absolute secrecy in all that pertains to a system of submarine mine defense is essential for its successful application in actual war, is responsible for the dictum that all aids in developing a mine system must emanate solely from the corps.

“It must surely be the sole desire of every government to procure the most perfect material available for the protection of her coast with a system of submarine mines, and whether it be the invention of members of our torpedo corps or of outsiders, ought not to interfere with its adoption. Of course it must be expected that preference will be accorded to that which emanates from the torpedo corps, but then a careful and exhaustive comparative test ought to be applied to establish its superior or equivalent value to similar material which may have been produced by outsiders.

“Secrecy in regard to plans of the submarine defense for each particular harbor is a desideratum to be secured in a most absolute manner: but secrecy in construction is to be deprecated, because by its adoption there is precluded the employment of the talent of those private individuals who are devoted to the work of improving the material connected with submarine mine defense; at the same time, past experience teaches the impossibility of maintaining the regular degree of secrecy in so far as the torpedoes of other countries are concerned if the secret matter is considered worth the price for which such information is always to be obtained.”

The foregoing has reference to foreign countries, but it applies with such exactness to our own situation that I would have supposed the author to be referring to us had I not known otherwise. The crux of the secrecy is in regard to plans; if this is provided for, little else really matters, though it is not recommended that one proceed to the housetops and proclaim what his appliances are.

The success of the submarine mine in the Civil War stood out in such bold relief that the question of incorporating the submarine mine as an element of our harbor defense was decided upon soon thereafter; however, the consideration of the matter was delayed much longer than conditions would seem to have warranted. Early in 1869 experiments and investigations to develop a system of torpedo service applicable to harbor defense were recommended by a board of engineers for fortifications, General Henry L. Abbot being associated with the board for the consideration of the subject. As a result of the labors of this board, based on experiments and investigations conducted by General Abbot at Willet's Point, New York Harbor, a system of submarine mining to be controlled and operated by the Engineer Department was adopted in the early seventies. General Abbot's experiments and investigations, parts of which were published in “Professional Papers No. 23, Corps of Engineers”, in 1881, constitute an example of scientific experiment of the highest order, and have received recognition throughout the scientific world. He investigated in a scientific way sub-aqueous explosions generally, developing simple and excellent apparatus to record the results. He published a list of explosives in order, according to



their usefulness in submarine mining. He investigated at the same time electrical fuses and igniting apparatus, both of which were then in their infancy. A perusal of his report is well worth the time of any one interested in these subjects.

Some physical phenomena in connection with sub-aqueous explosions may be of interest.

General Abbot says:

"Before proceeding to discuss, mathematically, the action of forces developed by explosions under water, a brief abstract will be given of notes relating to what is usually heard, felt, and seen in the vicinity.

"The sound is deadened to a surprising degree by the water over the charge. A large torpedo exploded ten feet or more below the surface, gives a dull muffled report that often is hardly noticed by one intently watching the jet. When the water covering is so thin as to allow the gas instantly to escape into the air, the sound is far more intense. Thus one pound of dynamite exploded three feet below the surface, produces locally a much louder sound than five hundred pounds submerged twenty feet.

"It is generally characteristic of small and deeply submerged charges of explosive compounds, and of some quick acting explosive mixtures as well, that at the instant of detonation, before any disturbance of the water at the surface is visible, three sharp sounds are heard resembling raps upon a hard substance. They are of nearly equal intensity; but the interval of time between the first and the second appears to be longer than between the second and third. That these repetitions are not simply echoes, and that there are really more than three of the impulses, although the ear hardly detects a greater number, have been conclusively proved in several instances where a gauge clutch happened to be out of order.

"Successive impulses may also be distinctly felt by one standing in a boat near the explosion; if the hand be placed in the water sensations resembling electric shocks are experienced.

"The influence of the shock upon fish is noteworthy. In the immediate vicinity, even of small charges, death appears to be almost instantaneous. At a greater distance the air bladder is ruptured and, the air ballast escaping into the abdomen, the fish floats upon its back at the surface, although still able to swim with considerable speed. At still longer ranges the effect appears to be momentary, simply causing an upward dart into the air. Even five pounds of dynamite will produce this effect upon a shoal of menhaden, at distances of several hundred yards, showing that the nervous system of that fish is one of the most sensitive of known gauges.

"The jet, as well as the sound, is greatly influenced by the submergence.

"A charge of one-fourth of a pound submerged about thirty five feet occasions no marked disturbance at the surface, but bubbles of gas continue to rise for many seconds. Fish at one hundred yards distance often leap into the air.

"A half pound charge detonated six feet below the surface produces a sharp report, and throws up a jet from twenty to thirty feet into the air.

"The effects exhibited by the sub-aqueous explosion of charges, large enough to be practically used for the destruction of shipping, will now receive attention.



"The height and form of the jet of water thrown into the air by a given charge, is observed to vary enormously with its submergence; and is probably a delicate index of the combined effect of all the forces transmitted to the surface of the water. The subject has been very carefully investigated at Willet's Point, both instrumentally and by the aid of instantaneous photography, and it has been found that the disturbing action even of very slight currents of air, the varying effects dependent upon the relative position of the sun, the jet and the observer, the excessive tenuity of the ill-defined cloud of mist which shrouds the main body of water, and lastly, the rapidity with which the different phases succeed each other, combine to throw too much uncertainty upon the phenomenon to render it a safe basis for important practical conclusions.

"A strong earth tremor, accompanied by a low rumbling noise always accompanied these sub-aqueous explosions. The rate at which such tremors traverse the earth's surface has been decided in connection with the experiments at Willet's Point, and were found to travel at from five to eight thousand feet per second."

As a result of his experiments General Abbot concluded that the merits to be sought in an explosive for the submarine mining service are:

1. The greatest possible intensity of action, when fired under water in such envelopes as are suited for submarine mines;

2. Retention of enormous strength under the conditions incident to the service, to-wit: lapse of time, alternate freezing and thawing with occasional wetting, and even saturation with water;

3. Convenience in loading, involving safety in transportation and in handling with ordinary roughness;

4. Market facilities; for it is undesirable that a large supply of any of these high explosives should be kept in store in our ports during peace.

He adds:

"The careful consideration of these several advantages and disadvantages leads the Board of Engineers to conclude that dynamite should be adopted provisionally as the best explosive for our service. Continual trials and many experiments have developed nothing to throw doubt upon the wisdom of that selection, but it is held always open to reconsideration.

"As new explosives appear they are carefully tested, and it is not improbable that the trials now in hand with explosive gelatin may show it to be a formidable rival."

Such was not the case, and dynamite was continued as the standard explosive until 1905.

The conclusion cited above, that large quantities of explosives should not be kept on hand, is the only one which is believed not to be sound.

During his experiments with respect to explosives, General Abbot developed a system of electrically controlled mines

FIG. 1

1371

Effect of a large charge of dynamite with submergence of a few feet

with shore apparatus for causing them to be fired at will or on contact. The system contemplated a casemate on shore, protected by concealment and location, well under ground, with cable reaching the water through subterranean passages. All parts of this system, even to the minutest detail of the apparatus, were kept secret.

It was realized shortly after the Spanish war, that it was practically impossible for our Engineer Corps to provide for and operate a system of submarine mining in addition to its other numerous duties. In the light of recent developments, it is of interest to note that certain individuals objected seriously to turning over this so called highly technical subject to the coast artilleryman as part of his duty. Hearings before the Military Committee on this subject as well as certain reports as to the capability of the artilleryman "to do the job" make good reading. However, a large majority of those responsible for the national defenses appreciated the merits of the case fully, and by an Act of Congress of 1901 the submarine mine system was transferred to the Coast Artillery Corps. The Engineer School was removed from Willet's Point to Washington Barracks, and the School of Submarine Defense was established at Willet's Point (now Fort Totten) with Major Arthur Murray (now major general), in command.

Departments for the instruction of officers and enlisted men in electrical engineering, submarine mining, and explosives were established, and the 54th Company of Coast Artillery, stationed at Fort Totten, was designated as a submarine mine company for the instruction of enlisted men in submarine mine work. Specially selected men were sent to the 54th Company for a year's instruction, and at the end of the year, were assigned to the various coast artillery districts, their places being taken up by new men selected from the coast artillery at large. In this way, there were developed gradually at all coast artillery posts, small detachments having a knowledge of submarine mining. At the same time the question of obtaining mine planters to proceed from harbor to harbor and give instruction was conceived, and during Mr. Elihu Root's service as Secretary of War, appropriations for four mine planters were obtained.

There were established at the School of Submarine Defense a depot for the purchase of torpedo material, and a Torpedo Board to conduct experiments and investigations

1372

FIG 2  
The School of Submarine Defense, Fort Totten, New York

2251

FIG. 3.  
A mine planter

1724

FIG. 4.

The Coast Artillery School Building, Fort Monroe, Virginia

with a view to improving and developing submarine mine material in all its details.

Realizing the force of the argument advanced early in this article, the Torpedo Board decided to utilize all sources available for the development of a modern system of mining. The board found several commercial concerns, notably the General Electric Company, of great assistance in developing certain material, and this article would not be complete without reference to the generous assistance given by Mr. Caryl D. Haskins (now deceased).

The Torpedo Board proceeded upon the following general principles:

1. All apparatus should be as nearly of commercial type as possible;
2. All apparatus should be strong, durable, and certain;
3. The system should be simple and effective;
4. The working forces employed should be of such a character that small derangements would not nullify the system, which is expressed concisely by saying that the system should be on an electric light rather than on a telephone basis;
5. The harbors should be fitted out completely in the order of importance rather than by dribblets, as has been the case with many of the other elements of defense;
6. The casemate should be well protected, but situated so that it will always be thoroughly dry, to insure the work of the electrical appliances;
7. There should be provided enough submarine mines to close any harbor within forty-eight hours from the time of the receipt of the order to proceed with mining operations.

As a member of the Torpedo Board, I was engaged personally in conducting many of the experiments which had for their object improving and perfecting the signaling, firing, mooring, and controlling appliances, and by the autumn of 1906 there had been practically perfected the system now in use; many of the important harbors had been equipped completely, and the projects for the remainder had been approved.

In 1907 Congress passed a bill authorizing 5000 men for submarine mine work, and it may be said that to-day this branch of the Coast Artillery Service is in a high state of efficiency. In 1908 the School of Submarine Defense was consolidated with the Coast Artillery School, and since then experiments in connection with the submarine mine system have been carried on by the Coast Artillery Board at Fort Monroe, Va.

Fig. 4 shows the Coast Artillery School Building, in the laboratories of which experiments and investigations are being made for the improvement of the mine service.

One of the features of the system which has given considerable trouble in its development, is an anchor which will cause the mine to be submerged to proper depth without the necessity of taking soundings or of cutting the mooring ropes to suit the depths. The latter was the system in vogue in '98, and the impossibility of mining effectively under that condition can well be appreciated. The principle of an anchor to accomplish this is very simple, and has been patented in many countries; but to perfect the mechanical details of an anchor weighing as much as 3000 pounds, seemed hopeless for a time. From 1904 until 1909 experiments were conducted with more or less regularity, and not until the latter date were our efforts crowned with success. However, to-day we have an anchor which meets all requirements.

The depressing effect of the tide has received considerable attention by submarine mine workers, and an apparatus which will allow the mine to rise and fall with the tide has been an attractive idea to many inventors. However, nothing practical of this kind is known, except apparatus tested recently at Fort Monroe. The device was invented by Captain Leon of Sweden. The mine has attached an electric motor by means of which submergence may be varied at will. It is a most ingenious device.

The search for an explosive, other than dynamite, for submarine mining received due attention from the Torpedo and Coast Artillery Boards; and wet gun-cotton, being the explosive used in automobile torpedoes and being perfectly safe to handle and easy to store, was seized upon as a most desirable substitute for dynamite. Some of it was issued and practice with submarine mines was ordered in the various harbors. Very soon, however, reports came in that the cotton did not detonate, and failures were practically universal. So a series of experiments to locate the trouble was decided upon and was conducted by Captain (now Major) C. H. McNeil, Coast Artillery Corps, under the direction of Colonel G. N. Whistler, Coast Artillery Corps.

As a result of those experiments it was found that the detonating wave from dry gun cotton would not pass through a material thickness of an electric conductor, but that electric insulators were perfectly transparent to such detonating wave.



As a result, the detonating charge in the mine was surrounded by hard rubber rather than by metal, and thus the liability to failure of the wet gun cotton was eliminated. It has been found since, however, that a large excess of water will prevent detonation of a high order, many statements to the contrary notwithstanding. And since the preparation of the dry priming charges for wet gun cotton as used in our system, presents some difficulty, it was thought necessary to make investigations

FIG. 5.

1225

Corrugated mine cases

with a view to substituting some other explosive. The result of these experiments was most satisfactory, and now we have an explosive which fulfills all the requirements. The experiments in connection with the new explosive were made by the Artillery Board, whose report is a confidential document, copies may be obtained from the office of the Chief of Artillery by officers of the military service.

An interesting item in connection with the charge of explosives is the statement made by General Abbot that charges greater than one hundred pounds do not produce effects commensurate with the increase in weight. This statement was made with reference to the effect at a distance from the detonating charge. However, the criterion as to the weight of charge should be based upon the effect in the immediate vicinity of the charge, and when viewed from this point the weight should be the maximum consistent with other considerations.

FIG. 6.

1276

Observation firing. Destruction of miniature battleship

This brings up the question of buoyancy. In order to obtain greater buoyancy with the same size of case, the corrugated construction recently adopted for increasing the strength with the decrease of material used, has been applied with a result that cases of all sizes have a greater buoyancy than those of the older type of construction. Such mine cases are shown in Fig. 5.

Another subject of interest which received the attention of the Torpedo Board, was the developing of a system of firing mines from observation. This method of firing is of

very secondary importance, but the possibility of utilizing it even on rare occasions, makes it worth while.

Fig. 6 shows the destruction of a miniature battleship with improvised apparatus similar to that used in our standard fire control system for submarine mining. The apparatus used for tracking the ship consisted of a couple of azimuth instruments, one on the parapet at Fort Schuyler, New York Harbor, and the other in an uncompleted tower on the old torpedo building used by General Abbot. Considering the difficulties connected with this experiment, the result of the first firing at the battleship is considered quite remarkable. I am free to confess I did not look for the result shown in the photograph.

Though the 54th Company had been a mine company for three years, no member had seen a mine explosion until that shown in the figure, and I will always remember the more or less consternation which existed when I informed the company that it was to use real explosive and not sand, in certain of the mines. It was quite remarkable what an effect that change in condition had upon the entire situation. The master of the ship and all others involved in handling the mines took on new life as it were.

All the handling apparatus was inspected and the greatest care was exercised in every detail in marked contrast to the manner in which mines had been handled when only sand was employed. This was one of the best illustrations that ever came to my attention of the fact that it is absolutely necessary to do in practice what you desire to do in action.

Since this first explosion of mines by coast artillerymen, loading and firing mines has become a yearly event at all our seacoast fortifications. The result of mine target practice averages over 90 per cent efficiency, 100 per cent being such a common occurrence that there is distinct disappointment if this percentage is not obtained.

In addition to developing the submarine mine system to its ultimate conclusion, the Torpedo Board considered the question of the application of the automobile torpedo and submarine boats to harbor defense.

The use of the automobile torpedo in connection with the other harbor defenses has always been an attractive one. One of the first appliances of this nature was the Sims-Edison torpedo which was experimented with at Willet's Point under the régime of the Engineer Corps. This torpedo was actuated by

an electric motor, receiving its current from generators on shore through a cable which unreeled as the torpedo sped on its way. It was a beautiful sight to watch the indicating balls attached to the back of the torpedo and projecting above the water. At times the apparatus would run beautifully, circling around marks and responding to every action of the operator on shore. However, the unreeling of the cable and other details complicated matters to such an extent that the apparatus did not function properly upon a majority of occasions; so it was relegated to the ash-heap in the late eighties.

The torpedo of the Whitehead type, which has its appliances for motive power self contained, has been installed in a few harbors, but a full consideration of the subject led the Torpedo Board to conclude that the proper apparatus for launching an automobile torpedo is a torpedo boat or submarine, and that for harbors where automobile torpedoes are desirable, there should be submarines or torpedo boats proper.

Many enthusiasts on the subject of automobile torpedoes have made extravagant and unwarranted statements as to their applicability to harbor defense, and I am convinced that the position of the Torpedo Board is absolutely sound. At present that position is the adopted policy of our service.

At a convention of all the powers it has been decided recently that a submarine mine must be rendered innocuous if broken from its mooring. This has been accomplished in a most satisfactory manner by the Harlee-Sauter Co. of France, the mine being provided with a hydrostat that locks the firing device as soon as the mine is free.

During the progress of the development of electrically controlled mines, inventors have not been inactive with mechanical mines. Special attention has been given to the character and efficacy of the firing apparatus and the most recent development in this connection is an attachment which prevents a mine from being fired by an adjacent explosion. I think the device interesting rather than necessary, as there is practically no danger of an explosion due to the highest charge, a short distance away. Good, strong apparatus inside a mine is far more important than a device for locking the firing mechanism for a greater or less time after a nearby explosion.

## APPENDIX

VESSELS DAMAGED OR DESTROYED BY MINES DURING THE  
RUSSO-JAPANESE WAR

The following instances may be cited of the operation of mines during the Russo-Japanese War:

On February 12th, 1904, the Russian torpedo transport *Yenisei* struck a mine which she had just laid in Taliénwan Bay and sank, 4 officers and 92 men being lost. The *Boyarín* in endeavoring to aid the *Yenisei* also struck a mine and subsequently sank from her injuries.

During the early morning of March 10th, 1904, a flotilla of Japanese destroyers, commanded by Captain Asai laid mines outside Port Arthur Harbor, to keep the Russian vessels from emerging.

On March 16th, a Russian torpedo destroyer (the *Skori*) while searching for mines near Port Arthur, struck one and was lost.

On the night of March 21-22, two flotillas of Japanese destroyers laid mines in the outer harbor of Port Arthur.

During the early morning of April 13, the Japanese mine ship *Koryu Maru* succeeded in laying some mines near the entrance to Port Arthur. About 8:30 p.m., the same day the Russian *Petropavlovsk*, while withdrawing before a Japanese fleet, struck two of these mines, and the explosion extending to the boilers and magazines, the vessel broke in two and sank. Of her complement of 650 men only about 6 officers and 30 sailors escaped.

The *Pobyeda*, while endeavoring to rescue the survivors of the *Petropavlovsk*, also struck one of the mines and was seriously injured. She succeeded in reaching the harbor, however, and was subsequently repaired.

In the latter part of April, the Russian destroyer *Bezshumni*, while searching for mines, struck one, and was seriously damaged. She succeeded in returning to port and was subsequently repaired.

On May 12th, while endeavoring to destroy a Russian mine in Kerr Bay, the Japanese torpedo boat No. 48 was struck by its unexpected explosion, 14 of the crew losing their lives.

The Third Japanese Squadron continued the search for mines in that locality, and on the 14th, when about to end the search for that day, a mine exploded under the stern of the dispatch boat *Miyako*, which sank in twenty-three minutes;

of the crew 2 were killed, 1 seriously injured, and 21 slightly wounded.

During this searching for mines the various vessels of the squadron occasionally bombarded points on land, some of which were occupied by Russians who were opposing the search for mines. No casualties seem to have resulted on either side.

On May 14th, during the absence of the Japanese blockading vessels, the Russians laid mines off Port Arthur in the path in which these vessels usually cruised. They returned on May 15th. The *Hatsuse* struck one of the mines about ten miles off the promontory of Liao-Tichan, and her rudder being damaged she signalled for a ship to tow her off; but about thirty minutes later she struck a second mine, which exploded the magazine, sinking the vessel almost immediately; about 300 of her complement of 741 men were saved. A Russian destroyer flotilla emerged from Port Arthur, but were repulsed by other Japanese vessels. The *Yashima* also struck a mine, and was taken in tow, but sank before reaching a place of safety.

On May 16th and 17th, a division of the Third Japanese Squadron, Rear Admiral Togo commanding, proceeded to Chinchou Bay, dragged for mines and entered the bay.

On May 17th, also, the destroyer *Akatsuki*, while engaged in the blockade off Port Arthur, struck a mine and sank.

On May 20th, a gun boat detachment and several torpedo boat and destroyer flotillas approached close to the harbor of Port Arthur to reconnoiter and plant mines, and were fired upon.

On the 13th of June, the Japanese mine laying ship *Taihoku Maru*, by the unexpected explosion of a mine she was laying, lost 19 killed and 17 wounded.

On June 23d, the Russian fleet (14 battleships and cruisers and 13 torpedo boats) made a sortie from Port Arthur. It was preceded by tenders and torpedo boats dragging for mines and came out safely. On returning, the *Sevastopol* either struck a mine or was struck by a torpedo, probably the latter. She was towed into the harbor.

On July 5th, the *Kaimon*, an old protected Japanese cruiser, was sunk by a mine.

On July 9th, about 7 a.m., 5 Russian war-ships, 2 gunboats and 7 destroyers came out of Port Arthur, preceded by a number of vessels dragging for mines. The Japanese torpedo boat flotilla fired on them to retard the searching for mines. About 4 p.m., the Russian vessels returned to the harbor.

On July 26th, while dragging for mines near Lungwangtang (Swansons Point), one of the Japanese gun boats got the clearing rope entangled in her propeller, and beginning to drift toward Yenchang Promontory, was fired upon by the fortifications and attacked by one or more Russian torpedo boats, which steamed up and discharged torpedoes. Commander Hirose, commanding the clearing party, approached on another gun-boat and towed the disabled vessel out of danger.

On July 26th, while cruising off Port Arthur, the Japanese cruiser *Chiyoda* struck a mine but was towed in to Dalny.

On July 27th, while returning to Port Arthur from a reconnaissance, the Russian cruiser *Bayan* was struck by a mine near the entrance, but was towed into the harbor.

About 8 a.m. August 10th, the Russian fleet of 10 warships, 8 destroyers, and a hospital ship emerged from the harbor of Port Arthur. The Japanese torpedo boats on the watch about six miles out, hovered about and preceded them. The Russians claimed that the Japanese torpedo boats, of which a total of 30 took part in the engagement, steamed ahead of the Russian column, sowing floating mines. The Japanese denied using any mines on this occasion.

On August 23d, the *Sevastopol*, while outside the harbor of Port Arthur, bombarding the left flank of the Japanese Third Army, struck a mine and was towed back into Port Arthur.

On August 24th, the Russian destroyer *Vainoslivi* struck a mine and sank about two miles off Laotieshan; a second destroyer struck a mine about the same time but was towed back into Port Arthur.

On September 3d, the Japanese destroyer *Hayatori*, while engaged in the blockade of Port Arthur, struck a mine and sank.

On September 18th, the Japanese coast defense vessel *Heiyen* struck a mine in Pigeon Bay and sank; only 4 out of her complement of 289 were saved.

On November 30th, the Japanese cruiser *Saiyen* struck a mine while cooperating with the Third Army at Port Arthur and sank; of her complement of 16 officers and 213 men, the commander, Captain Tajimi, and 38 others were lost.

On December 12th, the Japanese protected cruiser *Takasago* struck a mine off the entrance to Pechili Gulf and sank; only 133 of her complement of 500 men were saved.

This list shows not only the wonderful effectiveness of mines, but the necessity of having not only an effective, but also a safe, system.

# THE DEVELOPMENT OF COAST ARTILLERY TARGET PRACTICE

BY MAJOR HAROLD E. CLOKE, COAST ARTILLERY CORPS

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The history of the development of target practice with coast defense guns in the United States, begins with the very origin of the making of the nation. In the very earliest of times, that is, during the American Revolution, there were many heavy smooth bore guns mounted in the various forts of the United States, but no records are available to show that target practice was held as a matter of regular routine at any of them. However, these guns were frequently fired during times of peace in order to obtain a general idea of the strength of the powder.

Down to a period within the memory of men still living, that is the Mexican and Civil wars, seacoast armament played rather a minor part in the tactics of war. Since that time the importance of seacoast forts has steadily grown. It was during the Civil war that the importance of seacoast fortifications was fully recognized. There were many occasions when the fortifications of a harbor were looked upon as the most important part of the tactical problem to be solved, one of the most notable instances being the defense of Fort Pickens, Florida. Throughout the whole Civil war this fort was held by federal troops under the command of different Union officers,—finally by Colonel Harvey Brown, 5th Artillery. It successfully met the bombardments from Fort Barrancas, and kept the harbor closed to the confederates until the very end of the rebellion. It succeeded in preventing the Confederates from using a most important base of supply, and its tactical value was of incalculable importance.

From about 1885 to 1895, the coast artillery of the United States was in a state of comparative chaos; this was due to the fact that the construction of guns and carriages had been entirely revolutionized—the breech mechanism had been invented,



and guns designed whose power was more than double that of the old, both in accuracy and in energy of hitting power. And as far as the artillery personnel was concerned this great change had come suddenly. The Endicott Board, in which the artillery had had no representation, had authorized the construction of many hundreds of high power modern seacoast guns and carriages and the erection of the necessary emplacements for them, and the construction and erection had proceeded under the sole direction of staff departments. The artillery consisted of but 5 regiments, and they included the field artillery. The service was blocked in promotion, there being many first lieutenants fifty years of age; and for officers of such age and grade, wedded to old methods of gunnery, the study of new was so difficult that it was not until 1893 that any serious effort was made to advance beyond the old methods of practical gunnery.

There were, however, officers in the artillery during that period who had the farseeing genius to realize the extent and magnitude of the task before them. It was during that period that General Rodman succeeded in introducing his discovery of the use of slow burning powder for heavy guns, and also that the 8-inch converted rifle was mounted in many of our forts. With this rifle and the Rodman powder many interesting records in target practice were obtained. Some of the records are shown in the accompanying tables.

Perhaps some of the greatest strides in the application of scientific gunnery were made at Fort Wadsworth, New York, about the year 1893. Target practice was held there in the face of great difficulties. The allowance of ammunition was small, appropriations for obtaining necessary material for targets, gunnery apparatus, etc., were very meager, and there was considerable opposition to even having target practice from many who at that time were called the "theorists" of the artillery. They were officers who believed that as much benefit could be derived by solving the problems of firing through mathematical calculation as by actually firing the gun itself at a material target. The theorists believed that an imaginary gun, of an imaginary caliber, could fire an imaginary projectile, with an imaginary charge of powder, at an imaginary target; that the exact deflection due to drift and wind could be calculated, and the exact elevation for the theoretical range computed; and that if any errors should be made it would be merely a fault of drill, therefore drill could be as easily perfected

# RESULTS OF TARGET PRACTICE HELD IN 1892

## FOURTH ARTILLERY

GUNS.

HITS.



\* Not considered in computing figure of merit, as all the batteries did not have practice with the 8" B. L. Rifle.  
Number of shots fired: Guns, 90; Mortars, 121. Regimental Mean Deviation: Guns, 56.6; Mortars, 73.6.

RESULTS OF TARGET PRACTICE HELD IN 1896

Regiment.	Batteries.	STATIONS.	GUNS.							Regimental order of merit.
			15" S. B.		10" S. B.		8" M. L. R.		Mean devia- tion.	
			1700 YDS.	2700 YDS.	1700 YDS.	2700 YDS.	3000 YDS.	YDS.		
Third Artillery.	A	Washington Barracks, D. C.	23.10	220.62	24.72	87.88	98.99	91.06	3	
	B	Fort Monroe, Va.	71.76	27.33	32.05	49.14	61.71	48.39	2	
	C	Light Battery								
	D	Fort McHenry, Md.	148.16	111.46	46.62	86.75	92.17	97.03	4	
	E	Washington Barracks, D. C.	166.64	182.81	109.55	45.77	110.07	122.97	9	
	F	Light Battery								
	G	Fort McHenry, Md.	109.70	107.30	77.62	79.20	141.55	103.07	5	
	H	Washington Barracks, D. C.	73.12	94.20	94.14	157.50	124.23	108.64	8	
	I	Fort McHenry, Md.	22.82	50.98	62.85	67.68	11.57	43.18	1	
	K	Washington Barracks, D. C.	196.40	100.00	38.73	116.62	85.73	107.49	7	
	L	Washington Barracks, D. C.	38.25	98.00	35.70	235.75	122.92	106.12	6	
	M	Instruction Battery								
	Fourth Art'y	A	Fort Barrancas, Fla.					171.57	171.57	2
M		Fort Barrancas, Fla.					119.93	119.93	1	

RESULTS OF TARGET PRACTICE HELD IN 1896 (Continued)

Regiment.	Batteries.	STATIONS.	MORTARS.										Mean deviation.	Regimental order of merit.
			13" S. C.		10" S. C.		10" Siege.		8" Siege.					
			2000 YDS.	3000 YDS.	2000 YDS.	3000 YDS.	1000 YDS.	1500 YDS.	1000 YDS.	1500 YDS.				
First Artillery.	A	Ft. Hamilton, N. Y.	55.14	83.75	101.58	249.57	40.59	177.41	72.05	160.35	117.55	5		
	B	Ft. Columbus, N. Y.	91.18	211.11					78.20	148.83	132.33	7		
	C	Ft. Wadsworth, N. Y.	105.25	232.20			64.60	116.67	72.44	51.92	107.18	4		
	D	Ft. Wadsworth, N. Y.	138.70	373.27			75.98	170.63	63.78	118.27	156.77	9		
	E	Light Battery												
	F	Instruction Battery												
	G	Ft. Hamilton, N. Y.	90.97	102.37	122.45	186.95	45.46	119.29	64.42	93.28	103.15	2		
	H	Ft. Columbus, N. Y.	86.66	330.28					77.20	112.86	151.75	8		
	I	Ft. Hamilton, N. Y.	140.59	119.67	107.36	234.76	62.81	87.08	107.21	153.66	126.64	6		
	K	Light Battery												
	L	Ft. Wadsworth, N. Y.					60.52	152.92	113.94	70.42	99.45	1		
	M	Ft. Columbus, N. Y.	127.94	200.04			55.57	87.29	68.15	92.10	103.68	3		

without firing the gun as with. In the face of such difficulties as these, the younger officers in the artillery of those days had much to combat in order to obtain any practical results in gunnery and target practice, and great credit should be given our "Old Masters" for the work they did in those dark days of the Coast Artillery. It might be of interest to some of the younger officers of Coast Artillery to outline the general methods of firing the old types of guns and mortars during that period.

When target practice season was "on", the garrison became a regular beehive. There was trouble in the very air. It usually required from two to three weeks to actually fire five or six shots. The method of aiming the old mortars was perhaps the most interesting. In Figure 1 the general plan is illustrated. The range was obtained by means of two plane-



FIG. 1.

1227

#### Old method of laying mortars

tables located at the ends of a base line. When the shot was fired the alidades were set on the splash and by means of wig-wag, the angles were signaled in to the gun or mortar. Here, by means of the plane-table, the distance from the gun to the target (which was always anchored) and the overs and shorts were determined. The mortar was laid at  $45^\circ$  and the ranges corrected by varying the powder charge. The mortar was given its direction by first determining the "line of metal". This was done by stretching on the top of the mortar a chalked string which was in a plane of the axis of the piece and snapping it so as to give a white line on the top. Two trestles

with plumb lines were then so placed on the parapet as to determine a vertical plane approximately including the "line of metal" and accurately including the target; i.e., the two plumb lines and target were in the same plane. Another trestle was then placed in rear of the mortar and set in the same plane as the two trestles on the parapet. All three plumb lines and the target were now in the same plane. This having been accomplished, the mortar was then moved by handspikes until the "line of metal" also came into this plane. The mortar now had its proper "direction". The elevation was set by means of a crude quadrant shown in the figure.

The following brief outline condensed from Tidball's old manual of the methods of conducting target practice with 15-inch smooth bore, 8-inch Parrot, and 10-inch smooth bore is entered herein purely as a matter of historical interest.

"As this class of guns are chiefly used against ships, and are fired over the water, the target should be floating.

"For the 15-inch smooth bore and the 8-inch Parrot rifles, it should be moored at a distance of about 3000 yards; for the 10-inch smooth bore, the distance should be about 2000 yards.

"Plane-tables are employed for the purpose of recording the striking points of shots, or the bursting distance of shells. The tables are stationed, one at each extremity of a line, the length of which is accurately determined either by actual measurement or by triangulation from a base-line, the measurement of which has been made with care and precision.

"At every post mounting heavy artillery, a base-line should be so determined and permanently marked, to be used for the various requirements of artillery firing. About 1000 yards is a suitable length for it.

"The plane-tables are placed so as to have a clear view of the target, of each other, and of the guns. They should, furthermore, be so placed that the lines joining them with the target will intersect at as near a right angle as possible. This enables the position of the shot to be determined and plotted with greater accuracy than would be the case did the lines intersect with a very acute angle.

"The target [shown in Figure 2] is moored in position at the commencement of the season's firing, and is left out until the firing is completed. Its distance from the two stations and from the gun is determined by ordinary trigonometrical methods, or by plotting from plane-table observations.

"The plane-tables are the ordinary instruments described in works on surveying.

"After the table is set up at its station and adjusted, the officer in charge marks upon it the line to the target, to the gun, and to the other station. These lines form the bases for the subsequent plotting of the shots.

"The officer at each station is accompanied by a flagman to signal to the piece whether the shots are short or over. By this means the error, for subsequent shots, is approximately corrected.

"The officer in charge of the firing attends to the loading and aiming, sees that the charges and projectiles are weighed, and that the pressure plug

(when used) is properly attached to the cartridge; also that the fuses for the shells are of the proper length. When everything is in readiness, he directs his signal flag to be raised to inform the observers at the stations that he is about to fire. The piece is then discharged. The other officers at the battery attend to the stop-watch and telemeter.

"When the gun is fired, the officer at each station, sighting through the alidade, catches the point on the water where the shot strikes, or, in case of a shell, the point in the air where it explodes. He then draws a fine line to mark the direction, and gives it a number corresponding with the number of the shot.

FIG. 2.

1278

Old type anchored target

"The observations thus obtained are plotted. A suitable scale is assumed, (one of one inch to 100 yards is convenient), and the line joining the two stations is laid off, usually by the method of chords. The intersection of the lines to the target establishes its position, and those to the gun its position also. The distance from the gun to the target is ascertained from the scale. The lines of observation to each shot having been carefully numbered by the observers at the plane-tables, the intersections of corresponding numbers on the plot give the striking points of the shot, or bursting points of the shells.

"When plane-tables are not to be had, any instrument graduated for measuring angles and provided with sights through which the shots can be observed, may be used, and the work accomplished as just prescribed. An observer at the piece takes the time of flight with a stop-watch, and another observer obtains the bursting distance of shells with the Boulongé telemeter. The direction of the wind is determined by a vane at the piece. The most convenient and reliable method of noting it is by referring it to the dial of a watch held in such a position that the line passing through VI and XII will be parallel to the line of fire with the XII towards the target. The direction is that from which the wind comes. When coming directly from the front, it is noted as "twelve o'clock", when from the rear, as "six o'clock"; when from the right, as "three o'clock", when from the left, as "nine o'clock"; and from intermediate points, in a similar manner.

"The velocity of the wind is determined by an anemometer; but as this instrument is seldom to be found at military posts, the best that can be done is to estimate the velocity. When it is practicable to establish telegraphic communication, all of the foregoing operations, so far as signaling is concerned, are greatly facilitated."

FIG. 3.

1729

#### Old types of ordnance

Examples of old time seacoast guns and carriages are shown in Figure 3. The difficulties attending such methods of firing can be readily understood when we realize how dependent upon improved material the Coast Artillery is now.

As late as 1899 I have known target practice with a modern gun to last as long as a month. The officer in charge of the practice at this particular time made a vow that he would not shave until target practice was over. He had a full grown beard when the practice was completed!

Perhaps the most interesting period of the development of Coast Artillery target practice was between the years of 1899 and 1905. In the early stages of this period the method of conducting target practice was briefly as follows:



An order usually was issued anywhere from two weeks to one month in advance of the time when practice should begin, designating batteries that were to fire, the number of rounds, the velocity to be used, etc. The velocity to be used was reduced to about 1700 foot seconds for 8, 10, and 12-inch guns, and many of the old Parrot projectiles, which were rebanded, had to be fired first.

The target was practically the same as the present standard pyramidal, and was always anchored, moving targets not being permitted at that time.

The ranges used were between two and three thousand yards, sometimes less. The target was usually anchored the day before or early in the morning of the day of firing. A tug had to be hired for this purpose, as in those days the Artillery had control of no boats whatever. The system of fire control was practically the creation of the battery commander. He used whatever material he could find on hand at the post for making the different contrivances, for obtaining the range, the corrections to be applied to the range, the deflection due to the wind, etc. The system of communication between base ends and gun was usually by visual signalling, such as the flag and the heliograph. Posts which were fortunate enough to have some of the old Bell telephones, did obtain some practical results in this respect; but usually the telephone lines were so poorly constructed that the telephones would fail to work almost invariably at the critical moment. A plotting board was used to determine the range from the gun to the target. Figure 4 illustrates the method of constructing the original plotting board.

The sights used were of the sliding bar type with open peep hole and a double cross wire for a front sight near the trunnion. Some guns, however, at this time were provided with the old telescopic Scott sight which gave an inverted image. Some posts were provided with the emergency, Type B, Lewis position finder, but there were seldom more than one of these. The angles from the base ends were determined by means of either the transit or the old style "azimuth circle". The ranges were usually sent in writing by messenger from the plotting board to the gun.

Within a very few years from this period, in fact but a year or two, officers of the Coast Artillery who had inventive genius came to the front. Money was supplied by the Board of Ordnance and Fortifications for the purchase and construc-

tion of various forms of experimental apparatus, and it was not long before a general awakening came, when every officer in the artillery was using a little pet scheme of his own. It was a common question for one officer to ask another what system of fire direction he used in target practice. Many officers in going to target practice would be so covetous of their special schemes that they would actually hide them from brother officers as securely as if they were hiding them from the enemy. There were officers all over the artillery working and thinking night and day of some particular system of fire direction.

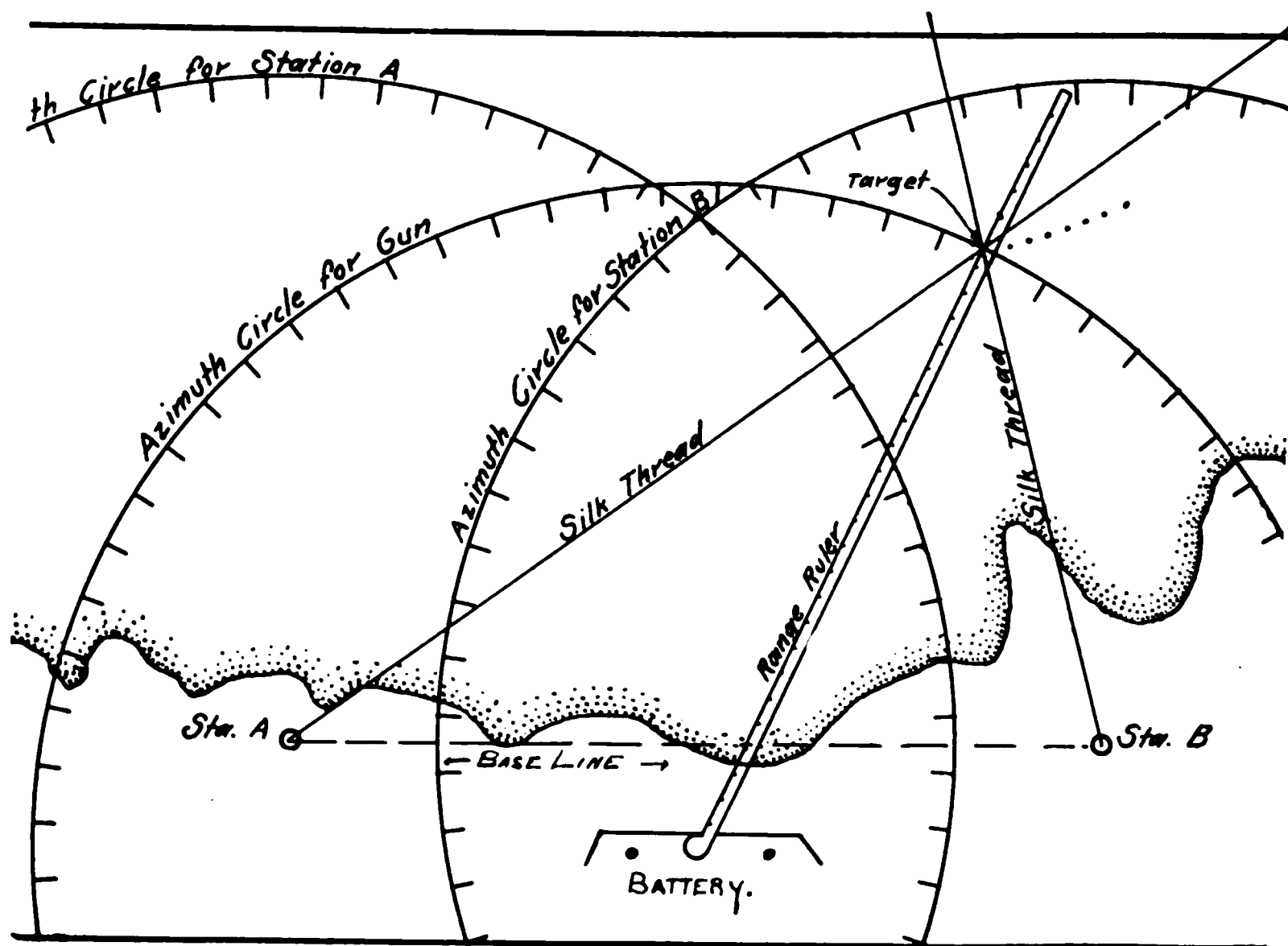


FIG. 4.

1230

Old style plotting board

Nor were these officers confined to Fort Monroe and Barrancas, but were up and down the Atlantic Coast and out on the Pacific Coast.

It was about this time that the great Barrancas tests were made. Some efficient system of fire control had to be devised, and devised quickly, for it was now well understood that a seacoast gun without range finding apparatus, a system of communication, and devices for controlling the fire, was as worthless and helpless as a steamer without a propeller. The Barrancas tests developed the nucleus of our present system of fire control. This system was afterwards perfected and brought

to its present high state of efficiency and scientific exactness through the results of target practice by the Coast Artillery at large, and through individual reports by many officers who had made a special study of the subject.

In contrast with the above methods of conducting target practice, let us consider present methods.

The end and aim of all things pertaining to the firing of heavy guns has been to reduce all of the operations to a purely mechanical basis, and to eliminate as far as possible the personal error of the individual. Some of the steps taken in order to accomplish this have been the use of reference numbers, the use of degrees and hundredths instead of degrees and minutes, the use of mechanical adding and subtracting machines for determining the corrected ranges and corrected deflections, etc., etc.

The targets now used for guns are material targets shown in Figures 5 and 6 and are towed at the rate of seven to ten miles per hour. The 60 ft.  $\times$  30 ft. target is for guns of 4.7-inch caliber and above, and the 10 ft.  $\times$  24 ft. for 3-inch guns. For mortars the pyramidal target marks the center of an hypothetical circular target. The ranges employed are as great as eleven thousand yards for the larger caliber guns, about five thousand yards for the medium caliber, and about three thousand for the 3-inch gun.

Where it previously required two weeks to fire four shots from one gun, it now takes under the most favorable conditions, but one day to fire from four to six batteries.

In the old method of counting hits the splash and the target were plotted at the same time, and thus the over or short determined. A plan of the hull of a battleship was then drawn to scale on a piece of heavy cloth-back paper, and the shots were plotted, using the center of the ship as the center of the target. If a shot fell within the limits of the deck of the ship it was counted a hit. The vertical extent of the hypothetical target was fifteen feet free board and five feet sub-water, a hit on the vertical section being determined by plotting, knowing the angle of fall. Shots were plotted for both broadside and head-on positions.

The present method is to count hits on a material target. And, by way of illustrating the great advance in accuracy of method, it may be remarked that now for the record shots the velocity of the powder is determined by means of firing a series of trial shots at a fixed target, even the velocity assumed for those trial shots being corrected for temperature.

FIG. 5  
Views of targets

1231

FIG. 6.  
Material target, 60 ft. x 30 ft.

1.32

## RÉSUMÉ

Thus it is seen that in twenty years coast artillery in the United States has risen from the condition of firing old smooth bore guns having a velocity of a 1000 foot seconds, to the modern high powered breech loading rifle having a velocity of almost three times that number. Where one fired a projectile weighing 100 pounds, the modern 16-inch gun fires a projectile weighing 2400 pounds. Where the system of range finding used to be by means of plane-tables and wigwag, the modern is by means of vertical and self-contained horizontal base position finders. Where in the old days it required two weeks to make two hits, we now make 100% hits firing 4 shots with one 12-inch gun in a little over one minute and a half. Where in the old system the accuracy of fire depended largely upon the personal ability of one gunner, to-day through mechanical and electrical invention the work incident to firing a heavy seacoast gun is successfully distributed amongst many, and largely freed of the possibility of personal error on the part of any one.

No better test of the efficiency of the coast artillery exists than that evidenced in its target practice with guns, mortars, and mines. For it will be readily understood that the ultimate object of coast guns, mortars, and mines is to hit hostile ships engaged in attacking fortifications or cities and shipping defended by fortifications; and the increased hitting efficiency of the Coast Artillery during the last ten years, is indicated by the statement that in 1900 the best results of target practice with large caliber guns was obtained by a battery which scored 50 per cent of hits upon a target representing a battleship 350 feet long 72 feet wide and 20 feet high at a range of 4500 yards, firing at the rate of one shot per gun every three minutes, while during the past two years 100 per cent of hits has been obtained by many batteries on a material target 30 feet high by 60 feet long at a range from 7000 to 9000 yards, firing at the rate of one shot per gun every thirty-five seconds. It thus appears that the rate of fire has been increased five times; and, when we consider the variation in trajectories at 4500 and 9000 yards, the accuracy of fire seven times. In other words, the best trained detachment of to-day will in a given time; score 35 times as many hits on a 30 foot by 60 foot target as did the best trained detachment ten years ago, on a target 350 feet long by 20 feet high. Again, ten years ago all of the target

practice of coast artillery took place at fixed targets; while now both guns and mortars fire at moving targets, notwithstanding that when mortars were planned for our fortifications, it was thought their fire was of an accuracy only sufficient to warrant their being used against a fleet at anchor. But with our present methods and material it has been found that the accuracy of mortars in firing at moving targets is not less than 50 per cent of hits on a battleship at any range up to 15,000 yards. Such results have been accomplished through coordination, systematization, and adoption of uniformity of method in the practical instruction of our coast artillery.

Formerly, our coast artillery was actually inferior to that of any in Europe, now it is superior in efficiency and effectiveness to any in the world, a fact recognized and admitted by all foreign attachés. And it is believed our progress can be attributed mainly to the fact that our Coast Artillery Corps now has a head who can represent its interest, prescribe uniform methods of instruction, uniform methods of drill, and efficient methods of conducting target practice; whereas when we had no Chief of Artillery, we had no system, no uniform regulations for drill even, the artillery being composed of a number of isolated batteries which were called upon for all kinds of duty.

The wisdom and foresight of Congress in its reorganization of the Coast Artillery cannot be better justified than by citing the fact that since it authorized the increase of the Artillery and gave it a Chief, the results of target practice show that we have increased in accuracy of fire seven times and in rapidity of fire five times, or are thirty-five times more efficient now than we were before Congress provided for our needs.

## **Honorable Mention, Essay Competition of 1911**

### **HOW MAY THE BEST RESULTS AT COAST ARTILLERY TARGET PRACTICE BE SECURED,—INCLUDING PRELIMINARY INSTRUCTION, TRAINING, PREPARATION FOR, AND CONDUCT OF, PRACTICE,—FOR GUNS OF 8-INCH TO 12-INCH CALIBER**

BY CAPTAIN ROBERT E. WYLLIE, COAST ARTILLERY CORPS

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At the outset, it is important that a clear understanding be had of the reasons for holding target practice. A very common idea is that the practice is the summation of artillery work, that the gunners' classes, drills and preparation, are merely for the purpose of giving instruction for target practice. This is a grave error; the culmination of our artillery work is war itself, and target practice is simply one of the means we have for obtaining instruction in gunnery. The word "obtaining" is used advisedly, as the whole personnel is under instruction: all are supposed to benefit by the practice. The battery commander is the instructor of his men in the gunners' classes, but when it comes to service practice, he can learn as much from the results as his men can; in fact more, if he will take it in the proper way.

Our entire training is for the purpose of hitting the enemy in actual war, and to do that we must know our weapons and how to handle them, what they are capable of doing and how to get the best out of them; and no form of instruction is at all comparable with target practice in teaching these things, and our methods of practice should be those which will give the maximum amount of such instruction. A common criticism of some particular feature is that it does not represent service conditions. But that is not the proper criterion, for if the feature improves our shooting it fulfils its purpose, as that makes us more efficient under service conditions. When holding target practice we are learning, while in war we apply what has been learned.

This mistaken idea of target practice is one of the reasons

why we do not get the full benefits of it. A battery commander will work with his battery for months, drilling and instructing, checking his guns and instruments, trying to get ready for what appears to him as the crucial test, the examination as it were, of his command. He has his practice and then considers everything as over, a good record causing rejoicing, and a poor one despondency, with complaints of luck or powder. He usually makes no attempt to find out why he was unsuccessful, whether it really was the powder or not, and the result is a failure to gain any knowledge from what should have been the most instructive work of the year for him.

If we compare our target practice with that of the Navy, we find that we are considerably behind them, not in the actual percentage of hits made, for our average is greater than theirs, but in relative results, taking all circumstances into consideration. Battle practice in the Navy is now at greater ranges than ours, fired from an unstable platform, sometimes in heavy seas, and with the crudest kind of a range finding system. Each ship has its own problem, prepared in Washington and not imparted to any body on board until the ship is on the range. Compare these conditions with ours, where the range is selected by the battery commander\*; where the guns are on immovable platforms; where if the weather is very bad, practice is not held, because the tugs cannot tow the targets; and where a range finding system with a horizontal base hundreds, and sometimes thousands, of yards long; and range, deflection, and plotting boards of an accuracy very much within the errors of the gun are employed. Pondering on these facts, we wonder how the Navy ever hits the target at all, for we must recognize that if our conditions were as hard, exceedingly few hits would ever be made.

What differences exist between the two services, that are responsible for this condition of affairs? In the opinion of the writer they are two in number, one inherent in the services themselves, the other capable of being eliminated. The first is that naval men live, move, and have their being with their guns. Guns in the wardroom, guns in the staterooms, hammocks slung above them, meals eaten alongside them, couples dancing around them; in fact, while on sea duty they cannot be gotten away from—they are ever present. The members of the personnel themselves being always together, shop talk is absolutely essential and can hardly be avoided. The result

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\* Written in 1911.



of all this is that the naval man knows his guns and knows them thoroughly, a junior rapidly absorbing information from his more experienced seniors, and the entire personnel acquiring knowledge in a manner and with a rapidity which is impracticable under the conditions existing in our service.

The second difference lies in the fact that the naval officer fully realizes the instructional value of target practice. This is the key note of the revolutions worked by Capt. Percy Scott in the British navy and Commander Sims in our navy. A battleship steaming by a 17 ft. target, at a buoyed range of 1400 yds., at exactly 10 knots per hour, was an object almost of derision at first, and very likely still is to many artillerymen. But the fact remains that it taught the personnel how to use their guns, what those guns could do, and how they could be made to hit the target. The present scores of the Navy at long range battle practice would be impossible, without the preliminary instruction gained in short range firing. This is merely one illustration of the value placed by the Navy on target practice as a means of instruction. Of course the War Department authorities are as fully cognizant of that value as the Navy is, but the mass of our officers are not, while it is universal in the Navy. This difference we can correct, and until we do, we must expect to find the Navy shooting the better, considering the difficulties under which they labor. When the artilleryman has properly grasped this idea of his service practice, he is on the high road to improvement, progress being then merely a matter of detail.

In considering the matter in detail the writer will commence with the analysis of a practice which has been held. This might appear to be starting at the wrong end, but an analysis is so instructive, that it will at once suggest improvements in the conduct of the practice, and in the training and preliminaries thereto.

The first query that arises in this connection is regarding the purpose of an analysis, what should it accomplish? Instruction and consequent improvement is the answer in general terms; specifically, everything should be taken up in detail, the responsibility for errors determined, and means taken to guard against them, in future. There are two general sources of error, those of matériel and those of personnel. The former cannot be corrected by the artilleryman. He can get his matériel into prime condition, and in that way reduce the error to a minimum, but beyond that he cannot go, the

inherent defects must remain; but the errors of personnel can be corrected. If the shooting is off the target, it is only too common for the powder to be blamed, while if an effort is made to check all the details of the practice, it will frequently be found that the errors of personnel are greater than those of matériel. It is therefore of the first importance that the two different kinds of errors be separated, and any analysis should include this feature. In order to do this, it is very evident, that complete records of everything that happens should be kept. This is a feature to which many object, "too many records have to be kept" being a frequent growl. It is impossible to keep too many records at target practice, or have too many checks. The more there are, the better the analysis that can be made from them, and the more the instruction afforded by the practice.

Now for the analysis itself, commencing with the trial shots: Check the plotting of the tug and target from the records of the B' and B'' observers. There is no excuse for inaccuracy on the part of the plotter here, but errors might have occurred. Determine carefully the actual range to the target, the distance from the tug to the target, and the angle at the target between the lines to the gun and the tug. Go to the range board and determine the corrected range on the atmospheric data, the tide, and the M. V. assumed. Check this with the corrected range actually laid at the guns. It is conceivable that errors will have occurred in this; indeed the writer knows of one case where the range board operator got between the wrong velocity curves, with the result that the corrected range was based on an M. V. 10 f.s. more than that directed by the B. C. The latter did not check, and the result, of course, was that the M. V. he assumed for his record series was 10 f.s. in error. In another case, the B. C. added as a danger space correction to the height of tide, the same amount that he intended to add for his record series, and then forgot to allow for that in getting his average range deviation, with the result that his correction from trial shots was 30 yds. in error, causing of course an erroneous M. V. to be assumed for his record shots. We are all liable to make mistakes, so everything should be checked. If any error is found in the corrected range actually employed, work the range board backwards, considering the error as being in the velocity, and determine what M. V. was actually used in firing the trial shots. This now becomes the "assumed M. V." for trial

shots, and is the figure that should go on Form 819, instead of the M. V. originally directed, as that was not used.

Now plot the splashes. The best way is to plot the positions of the tug and the target on cross-section paper, say 50 yds. to the inch, and plot the splashes, using the camera records and the record of the deflection observer. Of course, if the angle at the target between the lines to the gun and the tug is a right angle, and all shots were line shots, the camera record shows the actual range deviations, and plotting is unnecessary, but this condition rarely, if ever, occurs. It may be remarked that while it is practically universal to correct for the tug angle, very few battery commanders take the deflection of the shot into account, and this can make a very considerable difference, particularly if the tug angle differs much from the normal; so it should always be corrected for. If camera records are not available, use the range rake observations, experience showing that they are almost invariably nearer to the camera records than those made by plotting the B' and B'' observations. If the position of either the tug or the target changed between shots, this should, of course, be allowed for in plotting the splashes.

The B. C. now having all the necessary data for a consideration of his trial shots, the proper procedure is to determine the deviation in range of the centre of impact of the trial shots, and, applying that on the range board, to obtain the M. V. actually developed by those shots, which will be the M. V. to be assumed for the first record series, corrected, of course, for any change which may have occurred in the temperature of powder between the trial and record series. Sometimes a battery commander will discard one of his trial shots as being abnormal, because it fell too far away from the others. This is a matter, of course, for his judgment, but has he ever any justification for it? If his powder was well blended, and the charges all made up correctly and of equal weights; if his projectiles were approximately uniform in weight, calipering, and ramming, and if the laying for all shots was identical, it is difficult to see why the result of one shot is not entitled to as much weight as the result of another. The B. C. should know whether the above conditions actually obtained or not, for every one of them should have been attended to under his personal supervision, and he should know positively the facts in the case at first hand. If there is any doubt regarding one particular shot, then perhaps it ought to be thrown out, but if it

is merely a doubt as to the accuracy of the entire work, then again all shots are entitled to equal weight. From the report of the Board on Accuracy of Fire, published in the September-October, 1911, number of the JOURNAL, it will be seen (p.185) that the width of the 50% zone of the particular 12-inch gun used by the Board, was 178 yards, at a range of 8000 yards. Of course, no two guns are alike, but this can undoubtedly be taken as an approximation, fairly correct for any 12-inch gun; at least it is better than no data at all. A 50% zone of 178 yds. wide, means a probable error of 89 yds., that is, half the shots fired will fall less than 89 yds. from the centre of impact, and for any one shot, it is an even chance whether its range error will be less or greater than 89 yards. Eight times the probable error gives the 100% zone, or 712 yards. Now with these figures before us, we can see that, when firing at 8000 yds. with a 12-inch gun, every shot should fall within 356 yds. of the centre of impact; if a shot falls beyond that, it is undoubtedly abnormal; otherwise, but why should we so consider it? Half the shots should fall within 89 yards of the centre of impact. If we determine the centre of impact of all the trial shots, and find that half the shots are within 89 yards of it, no shot should be considered abnormal, unless, of course, the battery commander knows of some possible cause of error in one which does not obtain in the others.

In the pamphlet, "Coast Artillery Target Practice for 1910," is given the practice of one company, firing 10-inch rifles, which is instructive in this connection. The range for trial shots was 8040 yds. The probable error for 10-inch guns is undoubtedly greater than for 12-inch, but we will use the same figure, viz. 89 yards. The three trial shots fell +55, +63, -35, giving a centre of impact at +28; the dispersion was 98 yards, therefore all three fell within the probable error, yet the battery commander discarded the third shot as abnormal. This is probably an extreme case, but the writer has seen other instances of a similar character, and it is his belief that a battery commander is never justified in discarding any shot as abnormal, if it fulfills the requirements of the probability of fire specified above, and if the battery commander knows of nothing abnormal in the conditions of its loading or laying. He should, of course, use every possible precaution to see that such conditions are absolutely uniform, verifying everything personally, and getting results as accurate as the means at hand permit. On no account should either the corrected range

or the deflection be changed, during the firing of the trial shots, unless necessary to place the splash within the field of view of the cameras and range rakes. So far as the corrected range goes, this is usually followed; but the deflection is frequently changed, though there is precisely the same reason why it should remain constant as there is for keeping the corrected range unchanged, viz., to get an accurate determination of the deviation as a basis of correction for the record series.

The deflection sent to the guns should now be checked, just as the corrected range was, and, if any error appears, it should be thrown into the wind and the wind reference number corresponding thereto determined, just as the M. V. was determined on the range board. The mean lateral deviation at the target is then found from the deflection observer's record; and one advantage in keeping constant the deflection set on the sight should now be apparent, for if it has been changed, corrections will have to be applied in order to determine the true result. The mean lateral deviation at the target should be considered as due to an error in the wind, and the reference number corresponding to this deviation found. This number then becomes the normal for the record series, instead of 50, the regular normal on the deflection board; which means that the wind reference number for the record shots should be increased or diminished by the difference between 50 and the normal thus found.

Having determined his M. V. and wind reference normal, the battery commander is ready for his record series, and the analysis of the trial shots is complete.

The first series having been fired, let us proceed with its analysis.

The first thing is to determine the actual range to the target at the fall of shot, the data required in column 3, Form 819.\* There appear to be various methods in use by companies for doing this.

1. The reading of the primary instrument at the instant of fall of shot is taken (the instrument being on the target, of course), recorded, and afterwards indicated on the course of the target as the position of the latter at the fall of shot.

2. An auxiliary instrument, either in the primary station, an adjoining one, or in the immediate vicinity, is used as above instead of the B' instrument.

\* Written in 1911.

3. B' and B'' both take readings on the target at the fall of shot.

4. When a shot is fired, the plotter marks the last plotted position, and afterwards the range thereto is measured and recorded as the actual range.

5. The correction shown by the range board is applied to the corrected range, and the result is called the actual range.

The first and second of the above methods are both good, though the second is to be preferred, because readings at the fall of shot frequently conflict with regular readings, which causes a poor track, if the same observer has to take both. The same objection applies more strongly to the third method. Both the fourth and fifth are to be avoided. Assuming that the observing and plotting are correct, the range determined by the fourth method is that of the target when the observation was made, but the gun was laid on the set-forward point, which is one observing interval plus the time of flight ahead. Therefore, if the travel during that period is applied, with the proper sign, to the range thus found, the result is the range to the set-forward point, and this is the actual range to the target at the fall of shot, provided the gun was fired just as the target reached the predicted point, i.e., one observing interval after the observation was made. There is no means of telling in this method, whether this was actually the case or not, but let us see how much error could result therefrom. The range setter can hardly lay the gun in less than eight seconds after the observation was made, and, if 15 seconds was the observing interval (this seems to be almost universal for gun batteries)\*, this means half the time between the observation and the predicted time. Now the gun remains laid on that data, until the next corrected range is set, eight seconds after the next observation. Therefore the maximum error is  $\pm$  half the range travel during an observing interval. A target making a course of  $45^\circ$  with the line of fire, at a six mile speed, has a range travel of 33 yards every fifteen seconds; the error, in this case, would therefore not exceed 17 yards, and this amount is unusual, it being ordinarily very much less, as the course of the target is generally nearer  $90^\circ$  with the line of fire than  $45^\circ$ . A range determined in this manner (applying the range travel during one observing interval, plus time of flight, to the range when the observation was made) is sufficiently accurate, in the vast

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\* Written in 1911.



majority of cases, for all practical purposes, provided the observing and plotting were accurately performed.

The fifth method depends for its accuracy, not only on the observing and plotting, but also on accurate work at the range board, setting of correction box, reading of corrected range by plotter, transmission to and laying of the guns. With no mistakes in any of these, a range determined by this method is correct to within the same amount as the modified fourth method described above; but it is the checking of these very details that constitutes one of the objects of an analysis, and we cannot check them, if we assume them to be accurate. We must know the true range. The writer has the reports of six series in front of him, and, of the 36 shots in those series, a range determined by this method would have been correct in only five cases. Clearly this method should be avoided.

To sum up, a battery commander should use an auxiliary instrument to observe the target at the fall of shot, whenever that is practicable. If he has no competent man to spare for this, he might get one from another company, through the post or fire commander; or, where stations are grouped, the observer in an adjoining one could be detailed to perform this work. If still impracticable, the fourth method, properly modified by applying the travel, should be adopted.

The battery commander should carefully check the plot of the target from the recorded observations of  $B'$  and  $B''$ , and, when any point is distinctly off the general course, an error in the observation or reading is probably the cause; so a point on the course should be marked instead. A check can be had by requiring the F. C. detail to plot the target during each series on tracing cloth, marking the ranges to the target from the battery firing at the first and last shots. This can be superimposed on the plot of the battery, and any material difference, will at once suggest a check of the orientation of instruments and adjustment of plotting boards.

The position of the target at the fall of each shot, should now be marked at the point where the reading of the auxiliary instrument intersects the course of the target; and, with the gun arm at normal, the ranges to those points measured. They are the actual ranges. Now determine the range travel during an observing interval, by measuring the ranges to plotted points, several observations apart, and take a mean. Find time of flight for the corrected range used, and check the travel for one observing interval plus the time of flight,

with that recorded by the range officer as the amount used by the range board operator. This checks one item in the prediction.

If the actual range is to be obtained by the modified fourth method, measure the range to the plotted points checked by the plotter, apply the proper range travel, and take the result as the actual range at fall of shot.

Now record the corrected ranges at which the guns were actually laid when fired. And do not take for these the ranges shown in the range officer's report, for there may have been errors in transmission or in laying, or the pieces might not have been fired on the data the range officer thought they were.

It is well known that disappearing guns almost invariably change their elevation when going into battery; some jump up when the top carriage commences to move forward, and practically all jump down as it settles into place; and this sometimes amounts to a hundred yards or more. Carriages fitted with the elevating counterbalance appear to be the greatest sinners in this respect, as is natural. For this counterbalance being for the purpose of balancing the preponderance of the gun, it tends to throw the breech up, or depress the piece, which is the same action that takes place when the top carriage comes to rest in battery; and it follows that the friction device must be considerably more powerful to hold a piece fitted with this counterbalance, or the change in elevation will be largely increased.

Hence it is obvious that no advantage is gained in laying the gun before it is tripped, unless it is watched afterwards and corrected if necessary. The change is usually about the same every time for any one piece, although not invariably so; and a good range setter, by watching the action of his individual gun at drill; can tell just about where to set it, so that when it finally comes to rest in battery it will be at approximately the right setting; it can then be promptly corrected, but "range set" should never be called, until this has been done. The battery commander cannot be too careful in watching this point during drills and subcaliber practice.

There should be a good non-commissioned officer at each piece, during target practice, with the sole duty of observing and recording the actual setting of the piece at the moment before firing; and these records should be used as the corrected ranges for the fourth column of Form 819, irrespective of the range officer's report, or the telautograph record, or what the



range setter may say. In this case also, if the battery commander has no available men for the duty, the post or fire commander could detail them from other companies, as they are not for assisting in the practice, but merely for keeping the records of it.

Now proceed to the range board and find the proper correction due to tide, atmosphere, wind, assumed M.V., and whatever danger space correction the battery commander decided to use. It will be noted that travel is not included, because this function is applied during the firing to get the range of the set-forward point, and that we have already obtained. The range board is worked from left to right, making the travel correction the last to be applied. It would assist in an understanding of the principle, if worked in the reverse way, as we should then see that the travel is applied to the range at the time of the observation, giving the range to the set-forward point, the remainder of the corrections being applied to that range to get the corrected range.\*

The correction as found above should equal the difference between the actual and the corrected ranges, and any discrepancy that may exist shows an error of personnel. Such errors are to be expected occasionally; but the better trained the detail, the smaller and less frequent they will be. It is, however, a human impossibility to work at top speed, under pressure, and get every reading perfectly accurate; so a report showing no such errors is open to suspicion.

The next step is to determine at what range we should expect each shot to fall. Our assumed M.V. was that actually developed in the trial shots; we know exactly how the gun was laid, and what the proper correction was; therefore, if a shot develops the same M.V. as the trial shots, and that is what we expect, or rather hope for, it will fall at a range which can easily be determined. This we will call the "expected range," and it can be found by applying the proper correction as found above, without travel and with the reverse sign, to the corrected range plus the danger space correction. If all work was accurately performed, this will equal the actual range plus danger space correction, as this is the point that the battery commander wished to hit. Any error will throw it off by the amount of the error.

The actual range to the splash is next on the list. This should be found by plotting in the same manner as done for

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\* Written in 1911. The range board is now operated from right to left.

the trial shots. The writer has known battery commanders who took great pains in plotting their trial shots, carefully making the proper allowance for the angle at the target between the lines to the gun and the tug, and for deflection errors, and yet who took the straight camera records of their first series and obtained a new M.V. therefrom for the second series, no matter what course the target may have been taking, or what the deflection errors may have been, although it must be evident that the camera records merely give an apparent range deviation in this case, just as they do for the trial shots, and correction is just as much needed.

An example that actually occurred will be given, in order to illustrate how much difference this can make. The mean of the camera records gave the center of impact at 201 yards short; while plotting them with the observed deflection errors, and allowing for the angle made by the course of the target with the line of fire, gave only 157 yards short. Even if the battery commander does not intend to make any correction in his M.V., *actual facts* are desired on Form 819; and unless the camera records are properly corrected, they are not the actual facts in the case. It should not be forgotten that others will use the same battery, and the same lot of powder; so any accurate data that can be left will be of benefit. Emplacement books are full of erroneous and incomplete reports, which, if accepted at their face value, do more harm than good. Care should be taken to have them accurate.

Having thus obtained the range deviation of a shot from the target, apply it to the corresponding actual range, and the result will be the range to the splash.

The battery commander now has all data before him as to the ranging of the shots, and can proceed to study the matter. Inasmuch as it is always clearer to take actual figures, rather than abstract quantities, an extract from a practice that was actually held will be given.

The correction, omitting travel, should have been +320, of which 16 yards were due to  $7\frac{1}{2}$  feet having been added to the tide as a danger space correction. The range deviations of the shots from the target were -38 and -68 yards, respectively.

Shot No.	Actual range.	Corrected range.	Correction used.	Expected range.	Range of splash.
1	8100	8420	320	8116	8062
2	8050	8390	340	8086	7982

Since the true correction was 320, the above shows that the personnel made an error of +20 yards in the corrected range for the second shot; and this makes the expected range 36 yards over, instead of 16, as planned by the battery commander. The above figures were all determined as previously explained; for instance, the expected range =  $8420 + 16 - 320$  for the first shot, and  $8390 + 16 - 320$  for the second. The difference between the correction used and the true correction, gives the error of the personnel; and the difference between the last two columns, gives the deviation of the shot from where the range table tells us it should have gone, according to the M.V. developed in the trial shots with the atmospheric and other data for the day.

Shot No.	Personnel errors.	Deviation from expected range.
1	0	- 54
2	20	-104

Errors of personnel and matériel have thus been separated.

If we wish to find what M.V. was actually developed in any series, it should be clear that personnel errors must first be eliminated, as they cannot justly be charged to M.V. The above analysis has accomplished this, and if we take the mean deviation from the expected range (-79 in this case), with the M.V. assumed for the series, the range board will give the M.V. actually developed.

The following is a case that occurred. The mean of the deviations from the target was +63 yards, the danger space correction was +30, and the battery commander corrected for an over of 30 yards, giving a greater M.V. He did not check the work of his personnel or make any attempt to separate their errors from those of matériel. The facts were that, after eliminating the personnel errors, the deviation from the expected range, due to matériel, was -27 yards, showing that the M.V. actually developed was less than assumed for the series, instead of greater. The difference was due entirely to personnel, was just about the amount of his danger space, and threw him off the target.

In four of the six series previously mentioned, personnel errors were greater than those of matériel, the averages, per shot, being 53 and 50 yards respectively. An error of judgment is not here considered as being a mistake, although the subsequent result might show that it was.

The same general procedure should be adopted for checking the deflection, but it is much simpler. Determine the proper deflection (taking care to use the assumed normal for wind, as determined by the trial shots), and compare this with the deflection sent to the guns. There is no way of telling just how the gun pointer had his sight set, nor whether he was on the target at the time of firing, except his own statements. The only thing a battery commander can do in this connection, is to be sure of his pointer by selecting and training him with great care. One way to start a gun pointer on the right road, is to put the piece in battery, put up the subcaliber loading platform, set the sight at normal and insert the bore sights, or put threads across the breech and muzzle, then let an officer sight through the bore, and in that way check the pointing. Or if a trunnion is equipped with a bracket, and a Scott sight is on hand, the officer can better check with that. A pointer should be taught from the start, never to give the command "Fire" until he is on the target, no matter how much time is apparently wasted; and the battery commander should not repeatedly hurry a pointer during drills, lest the latter acquire the habit of firing when off the target.

In this connection another feature deserves mention. There is usually an appreciable time between the instant the gun pointer determines to give the command and the actual firing of the primer. This can be called the firing delay, and consists of the length of time necessary for the gun pointer to obey the dictates of his brain; the time required to say "Fire," or give the signal; the time for that to impress itself on the mind of No. 3; and the time for him to pull the lanyard, and for the primer to act. This delay is not long, but the target is moving all the time, and it might make the difference between a hit and a miss. So each gun pointer should be trained to give the command such an interval of time in advance that the piece will actually be fired as the center of the target crosses the vertical hair. The interval will, of course, vary for different men; therefore it is essential that the pointer and No. 3 be not changed when once trained. Subcaliber practice will give an excellent opportunity for seeing how well they work together.

The analysis of the first series is now completed; the battery commander has separated the errors of personnel from those of matériel; he has found the M.V. actually developed; and he knows practically everything that happened. Of course, com-

plications often arise; he may find one gun shooting further than the other for instance, in which case it will be necessary for him to decide whether or not he shall change the pointer on the range scale. In one case known to the writer, No. 2 shot 68 yards short of No. 1 in the first series; but the battery commander, neglecting to eliminate personnel errors, got a difference of about 90 yards between them, which he corrected for in the second series by moving the pointer. Then in the second series No. 2 shot 126 yards beyond No. 1, or 36 yards in addition to the 90 yards change made in the pointer. This shows that the battery commander made a mistake in judgment; and, when one considers the matter carefully, it should be evident, that data derived from only three shots from each gun, fired rapidly and at a moving target, is not sufficient as a basis for such a correction, unless it is corroborative of results shown in previous practices, at that battery. A battery commander should proceed with caution in a matter of this kind.

Other troubles may be found—extraordinary deflection errors, for instance, which he cannot account for, except on the assumption that his gun pointer was not on the target, while, perhaps, he has great confidence in that particular man. Or his errors in range, after eliminating the personnel error, may be beyond all precedent, and not to be accounted for by any ordinary error of the day. In such cases no pains should be spared in the effort to locate the causes, everything which could possibly have a bearing on the case being looked into. It should be seen that the anemometer, barometer and thermometer are properly calibrated; that the wind vane is oriented; if possible, meteorological instruments at some other point should be read as a check; an anemometer should be sent out on the tug, and its readings compared with those of the shore station; the guns should be re-clinometered; the orientation of instruments, and the adjustment of the plotting board, should be checked; the elevation friction devices of the carriages should be regulated; also, range and deflection boards adjusted and verified for the model of gun; the powder left in the magazines should be checked to make certain that all the charges used were of the lot recorded; the sights should be examined to determine whether the prisms are in place; the scales on which the powder was weighed should be balanced. In fact, no stone should be left unturned in the endeavor to find the trouble.

In the meanwhile the time for the second series is approaching, and the battery commander must decide what M.V. he will assume for it. This again is a matter for judgment, but the dictates of common sense require that he be careful not to depart, without good grounds, from the M.V. developed by the trial shots. Those shots were fired with much care and deliberation at a stationary target, while the record shots were fired rapidly at a moving target and under considerable strain, when the facilities for accurate work and checking were not nearly so good as for the trial shots. The results obtained from the latter should, therefore, be much more dependable than those from the record shots. It is believed to be unwise to discard the trial shots altogether in any case, although circumstances occasionally arise when a modification of them is justified. Such a case would be when the M.V. developed in the series was radically different from that shown by the trial shots, and no definite cause could be found for the difference. They must not be expected to check exactly, the "error of the day", as it can be called, being certain to cause some difference, though this should not be very great. By the "error of the day" is meant the effect of various unknown causes, differing from day to day, or even at different times of the same day, which operate to change the ranging of shots, and therefore, in our system, are considered as changing the M.V. These causes are unknown in the sense that we cannot predict them; for example, we cannot be sure that the wind over the range is blowing with the same velocity and in the same direction that the instruments in our meteorological station indicate; or that the barometer and thermometer give readings which are applicable to the particular atmosphere through which the projectile is to travel. From the very nature of the case, no definite maximum for the error of the day can be given, experience being the only guide a battery commander has in deciding whether the difference between the trial and record shots can be accounted for on that assumption, or whether there was some additional unknown factor. If he decides on the latter, some modification of the M.V. should be made, but it should be a modification only, the trial shots not being discarded entirely, as the possibilities of error in them are very much less than in the record shots.

An illustration, showing the undoubted influence of the error of the day, will be given. The trial shots gave a M.V. of 2156, which was taken by the battery commander for his

first series, in which the M.V. developed was apparently 2145; if the battery commander had used that figure for his second series, he would have gone over, because, as it was, the M.V. developed in the second series was apparently 2153.

After the second series is fired, the B. C. should analyze it in precisely the same manner as the first and then study the practice as a whole. The complete analysis, filed with the emplacement book, cannot fail to be of benefit to officers who may subsequently use that battery.

In the discussion of this analysis, we have already taken up several important details which may be said to belong, properly, to the conduct of the practice, the training and preliminaries, but there are still some to be commented on.

The report of the Board on Accuracy of Fire, previously referred to, shows that the adjustments of the carriage play a very minor part in accuracy, but they should not, on that account, be entirely neglected. The elevating friction device should be properly adjusted and all parts thoroughly cleaned and limbered up.

An important fact found by that Board was the effect of jump, which is analyzed on pp. 176 and 177, in the September-October, 1911, number of the JOURNAL, and the Board recommended that a jump curve be added to the range board to correct for it. Until this is supplied, it would be an act of wisdom, on the part of battery commanders, to draw the curve themselves on their own range boards. The data for it will be found at the foot of the table opposite p. 174, on the line "Jump range effect," and it will be seen that it varies from +123 yards, at a range of 1000 yards, to -42 yards, at 10,000 yards. This may make quite a difference in practice; and as the data is available to all, advantage should be taken of it. The jump determined by the Board, was for 12-inch guns on the model '96 carriage, but "it is reasonable to suppose that other disappearing carriages of similar design will behave in a similar manner." Plate III, facing p. 186, gives the curves for some different guns and carriages, and is well worth study and use.

Another important point in the Board's report has to do with the probable error and the probability of hitting deduced therefrom. This matter has been mentioned earlier, and one of its uses elaborated. The second column on p. 184 gives the width of the 50% zone, and the probabilities are given in succeeding columns. It should be noted, however, that those



probabilities are based on a target 15 yards in height ( $Z_r = 15 \cot \omega$ ; see formula, table, p. 184) whereas our practice target is but 10 yards high, therefore our target practice probabilities are less than those given. The danger space ( $Z_r$ ) at 8000 yards, is but 77 yards, instead of 116, the figure used by the Board.

A further application of the probable error is in correcting during a series, from observation of fire. In view of the discussion regarding the relative value of trial and record shots, as a basis for making corrections, it might seem, at first glance, that corrections should never be made during the firing of a series, but consideration will show that the conditions are not the same. When considering a M.V. for the second series, we have had time to analyze the first one completely, we have separated the errors of personnel from those of matériel, and we can consider calmly the actual behavior of the latter, unaffected by anything else. While a series is being fired, however, the battery commander is unable to tell what is causing his deviations from the target, whether they are due to errors of personnel, of matériel, or to the error of the day, and it really makes no difference at that moment; the important consideration at that particular instant of time, is that the shots are not hitting, and it is for the battery commander to put them in the proper place, the causes waiting for future determination. Until this year, our trial and record shots were fired on the same day, and the error of the day went into the assumed M.V., which gave accurate results; but, under the present rules, it can make a great difference, and when, in addition, the possibility of errors made by the personnel are considered, it will be seen that the battery commander should be prepared for such an emergency.

A case, to show the necessity for correction during the firing, will be given. The first three shots fell as follows: -146, -164 and -167, in range deviation from the target. We will assume a probable error of 89 yds., according to the Board's findings; for though the gun was not a 12-inch yet the range being considerably below 8000 yds., 89 yards is probably a liberal figure; and, for this purpose, it is better to assume too large rather than too small an error.

Since the probable error of any gun is such a distance from the center of impact, that, in the long run, 50% of the shots fired will have a smaller error, and 50% a greater, it follows that, with a probable error of 89 yards, if the center of impact is on the target, one half of the shots fired should fall closer to



the target than 89 yards; yet the nearest of the three shots under consideration was 146 yards from it. Therefore, if the remaining shots are fired without correction, the chances are very strong that the center of impact will be found a considerable distance short of the target; so if the battery commander can get fairly accurate data on those first three shots, he should by all means make a correction. No correction was actually made and the center of impact of the entire series was 157 yards short, the dispersion being from 137 to 181 yards short of the target. In passing it may be remarked, that this small dispersion would seem to show that the probable error was less than 89 yards. It therefore appears that the corrected range should have been about 190 yards greater, in order to get the center of impact on the center of the vertical target, and every shot would then have been a hit for range.

This was undoubtedly a case where correction during the firing was imperative, and the first question that naturally arises is, why such an apparent discrepancy existed between the trial and record shots. The subsequent analysis showed that the battery commander made errors in determining the M.V. developed during the trial shots; therefore the assumed M.V. for the record shots was incorrect. In the second place the remainder of the personnel made errors during the firing, averaging over 60 yards. Allowing for both of these, the ranging was still considerably short of what was expected from the behavior of the trial shots, the difference constituting the error of the day. The carriages at that particular battery have been tinkered with a great deal, and their behavior may be quite unlike that of the typical carriage. According to the meteorological station, a five o'clock wind was blowing during the record series, while out on the water it may have been a 12 o'clock wind, retarding instead of accelerating. These are put forward as possible explanations of the error of the day on this occasion, or part of it; but whatever the true reason, this practice shows the necessity for an accurate system of correction from observation of fire, and every battery commander should establish one.

This feature was fully appreciated in getting out our present instruction order, and battery commanders were authorized to adopt such a system, no correction, however, being made until after three shots should have been fired. The writer believes that the restriction was a mistake. A battery commander should be cautioned not to make corrections too

hastily, or on insufficient data, and he should understand how to do it; but two shots may show the necessity for a correction, and it is even possible for one to do so; therefore it should be left to the judgment of the battery commander, as other matters are. In the case we have considered, for instance, the first shot fell 146 yards short, and it would have been unwise to correct on that alone; but the second being 164 short, the probability became very great that the center of impact of the series would not be on the target, and there was no good reason why another shot should be wasted, before making a correction that was evidently required.

An estimation of the range deviation by the eye alone being absolutely worthless, something better than that must be adopted. The spotting system of the Navy can be utilized for the short ranges of rapid fire batteries, but our sites are usually too low to give good results with that system at long ranges; and, in addition, our conditions permit of the establishment of a much more accurate system than any the Navy can get. In the January-February, 1911, number of the JOURNAL, several methods are described, any one of which should give good results. The writer is inclined to favor Captain Hatch's logarithmic slide rule, familiarly known as "Hatch's divining rod," as being apparently the quickest, and at the same time most accurate, method yet suggested; but any system, based on sound principles and conscientiously followed, is better than none. The battery commander, however, must use it during his subcaliber practice, and both he and the details operating it must be drilled just as thoroughly as his other details are, for he cannot expect to pick it up and use it during service practice, without previous training. Use it for all subcaliber work and for the trial shots; use it also on targets during drills, checking the ranges found against those plotted by the regular range finding detail, thus determining how accurate the system is, and getting drill as well.

To be successful in correcting from observation of fire, the battery commander must have a well formulated plan for applying the data obtained. He must know approximately the probable error, and in the absence of specific information relating to his particular battery, he cannot go far wrong in taking that found by the Board on the Accuracy of Fire; for even if his battery is an 8-inch or 10-inch, a slight increase in the figures given by the Board will probably be a sufficient approximation, and within the error that will be made in obtaining

the range deviations during firing, whatever the system adopted.

If the range is correct, half the shots should fall nearer the point aimed at than the probable error; and the point aimed at being beyond the target a distance equal to the danger space correction, no shot should fall a greater distance than four times the probable error from that point.

Let us assume a range of about 8000 yards, giving a probable error of 89 yards. If the first shot falls more than four times  $89 = 356$  yards, from the desired place, the laying is wrong, and the battery commander should at once correct. In this case there is merely one shot as a guide, so it is difficult to know just how much to correct; but if the full amount of four times the probable error, 356 yards, is corrected for, the succeeding shot should unquestionably be nearer the target, although a further correction may be found necessary, and probably will be.

If the first shot is less than 356 yards off, but more than 89 yards, it is advisable to wait for the next shot, and if that is anywhere near the same distance and on the same side of the target, to correct for the average deviation from the point aimed at. But if the second shot is less than 89 yards off, it requires more consideration, for if it is on the same side of the target as the first, the chances are strongly in favor of a correction's being needed, and the battery commander cannot go far wrong in correcting for the probable error, 89 yards; while if it is on the other side of the target, the third shot should be waited for. And if that is less than 89 yards off, the range should be left alone, as there are now two out of the three shots within the probable error; but if it is more than 89 yards off, and on the same side as the first, which was also more than 89 yards off, correction should be made for the mean of the three shots; while if it is more than 89 yards off, and on the opposite side from the first, the fourth shot must be waited for. The fourth shot should be less than 89 yards off, if the laying is correct; for if the fourth shot is not within 89 yards, only one out of four shots has fallen within the probable error, and that indicates that a correction is necessary. So long as 50% of your shots are falling within the probable error from the point aimed at, make no change, even if the center of impact is not exactly at the point desired, for a correction is likely to do more harm than good.

In the case we have taken as an example, if the battery commander had followed the above course, he would have

corrected, after the second shot, by adding 185 yards to the range, because the first two shots had fallen 146 and 164 yards short; and the sum of their mean, 155 yards, and the danger space correction, 30 yards is 185 yards. Such a correction would have made all the remaining shots hits for range. All cases will not be as simple as this one, however; and it should be noted that the range deviations given in this case were re-plots from camera records, while by no system could the battery commander hope to get such accurate data during the firing. However, this does not affect the principle involved; so, by the adoption of a proper system, a battery commander can obtain approximately correct figures.

A question that often arises is regarding the proper aiming point—how much should be allowed as a danger space correction? If the range is so short that the probability of hitting is 100%, by all means lay on the centre of the materiel target; that is, add 15 feet to the height of tide, because to put it any lower is to throw away a good chance of direct hits for a poor chance of ricochets; while if the firing is beyond ricochet range (about 9° elevation), lay for the same spot, as ricochets are impossible. Between those two limits it becomes a matter of judgment. Hits are made from ricochets, it is true, but there is no relying on them, since too much depends on the condition of the water, what part of the wave is struck by the projectile, etc., for one to make any prediction regarding the projectile's further flight. As a matter of fact, at our target practice ranges, it makes practically no difference in the probability of hitting, whether the centre of impact is at the water line of the target or half way up; at 8000 yards the probabilities of hits, with a 12-inch gun, are 22% and 23% respectively, a difference which is negligible. However, the centre of the target is the correct place on principle, and the shorter the range, the more the probabilities favor that point.

The battery commander cannot be too careful in obeying the instructions contained in par. 659, C. A. D. R., and anything that is at all likely to get out of order should be examined before each series. This is particularly true of range finders, plotting boards, and sights. The guns should be clinometered each time.

Some battery commanders insist on a decreasing range, because the backlash in the elevating gear is then eliminated; others want the target going in one particular direction across the field of fire, because their plotting boards are adjusted to

eliminate the backlash in the index boxes, when moving that way. This should not be permitted.\* A battery should be ready to fire whenever the target is on the range. Backlash should, of course, be eliminated; but it should be done by training the range setter always to make the last motion one of depression; while on the plotting board, if the target is going the wrong way, make the arm setters go beyond the proper point, and then come back to it.

No detail of the training is so small that it can be slighted; the exact position of each finger of the arm-setters should be gone into, as time can be saved by proper methods; the plotter should bring the targ up against the intersection in the same way each time; the exact time during the rotation of the block, that the command "Trip" can safely be given, should be carefully worked out. Numerous other cases will at once occur to the mind, and every one is important, and deserves the personal attention of the battery commander and his officers.

A point worth considering is in the operation of the range and deflection boards. A few minutes before commencing to fire, the range finding detail should be notified, and the range and deflection boards should be operated very carefully, no pains being spared to get true readings, attention being paid to the travel, both in range and azimuth, and *average* readings being used. Unless the range changes considerably, or some times elapses, there should be no necessity for making any change in the corrections or in the deflection. Do not attempt to work the range board between successive readings. It cannot be done accurately at that speed, and there is no need for it, as the corrections will remain the same for a longer time than is required to fire the series.

The range and deflection board operators should be carefully instructed to take the *average* travel, and not to change it with every observing interval, for the target cannot really change its speed or direction rapidly, and differences in travel between successive intervals are only apparent.

At the beginning of the season, the battery commander should formulate, as a general plan to guide him, a progressive course of practical instruction for his battery. He should begin with the minutest details of each operation by each man, performed slowly and methodically, the speed being gradually increased as the men become proficient and able to work rapidly

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\* Written in 1911.

without losing accuracy. Then subcaliber practice should be engaged in, slowly at first, with a view solely to accuracy; then more rapidly; and finally it should be conducted just as service practice, all records being kept, and analyzed as far as practicable. All details then being ready, the step to service practice will be small, and everything should move with order and precision.

Subcaliber practice is too frequently treated as something to be gotten through with, a burden, instead of a valuable method of training. The instruction order limits the amount of ammunition which can be expended on any one day, and a great many appear to interpret this as an order to use that amount. The allowance should be conserved. A little firing twice a week or so, carefully conducted during the drill hour, will train the personnel infinitely better than shooting away the entire amount allowed in one morning, and firing no more for weeks. It is true that a battery commander cannot have subcaliber practice whenever he wants it, for the boat is under the orders of the district or post commander, and can only be obtained through him; but those officers are approachable, and the interests of their subordinates are also theirs; so if a battery commander asks for the boat, telling his plans, he will undoubtedly get it, if at all practicable. If, however, he shows no signs of interest, but merely sits tight and waits for orders, he cannot expect others to think for him. There are many demands on the boat, staff officers not hesitating to ask for it, when it is needed by their departments, so if a battery commander does not represent his needs, he has no one to blame but himself.

One great trouble at the present day, is a lack of knowledge of the fundamental principles of gunnery. An officer entering the service now, finds a perfected range finding system, in which he is an instructor of enlisted men; he is, therefore, confronted with the immediate necessity of learning the use and application of the different instruments, in order that he may impart that knowledge. The result is that, in the general case, he merely touches the high spots, learning to use the instruments almost without knowing why, certainly without a full appreciation, and he fails to grasp the underlying principles on which the whole system is founded. Our older officers really learned gunnery, for the instruments in use being crude, the solution of problems required the application of principles. And from the solution of those problems our pres-



ent highly developed system, which has almost become a science, has been evolved, those who saw it grow, learning, step by step, each improvement as it arrived, without losing touch with the principles involved.

There is no one book published which will teach the elementary principles referred to; the interchange and discussion of ideas and experiences will do more than anything else, and this, as shown earlier, gives the Navy an advantage over us. The writer recommends that a capable officer, preferably of field rank, be detailed in each district, to instruct in this subject and to supervise discussions. Schools of fire, at posts where much practice is held, as at Fort Monroe, Fort Hancock, Fort Terry, Fort Worden, etc., with good instructors in charge, would be of great benefit. The following works are recommended for study: "Seacoast Artillery Practice," by Major Ruckman, published in the JOURNAL in 1908 and 1909; the pamphlet "Gunnery," constituting a part of the Provisional Manual for Coast Artillery, now obsolete; and "Gunnery in Our Navy," by Prof. Alger, the prize essay of the Naval Institute for 1903. There are others, of course, but these are accessible, and a careful perusal of them will well repay the student.

We have made wonderful strides in the past ten years in our target practice, but there is still room for improving the general average. One officer compiled a comparative table from the published results of target practices for the past few years, and the most striking feature of it was the regularity with which certain officers appeared near the head of the list, and others near the foot, irrespective of changes they made in companies and calibers. This shows where efforts in improvement should commence, and in order to effect them, let us bear constantly in mind the words of Dickens in "David Copperfield," "Things cannot be expected to turn up of themselves. We must in a measure, assist them to turn up."



# IMPROVISED DEVICES

IN USE AT A TWO-GUN BATTERY EQUIPPED WITH DISAPPEARING CARRIAGES AND A CENTRALLY LOCATED PLOTTING ROOM

BY CAPTAIN, FREDERICK L. DENGLER, COAST ARTILLERY CORPS

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In an attempt to eliminate certain undesirable features of data transmission and service of the piece, when he assumed command of a battery in July, 1911, the writer, with the assistance of the two battery mechanics and largely from material on hand at the post, improvised the following described devices. All, except the modified time-range board, have successfully withstood the test of eight firings since November, 1911, use having been made of them with the approval of the artillery district commander, pursuant to paragraph 584, D. R. C. A.

A study of the faults of data transmission and service of the piece, as then installed and required, indicated that the following would be desirable:

1. The elimination of long and involved commands for putting the battery into action, and the evolution of a more simple system which could be efficiently employed under any condition of drill, practice, or action.

2. The elimination of errors in reading the curve of the time-range board.

3. A system which would increase the efficiency of service of the piece by:

- (a) Increasing the rapidity of loading without violating any of the prescribed precautions for safety;

- (b) Insuring the proper and uniform seating of the projectile;

- (c) Reducing the probability of mishandling the powder charge during loading;

- (d) Insuring the safety of personnel against the danger of inadequate sponging of powder chamber after each discharge;



(e) Providing a powder charge for drill which should resemble, as closely as practicable, the charge used for service.

4. A system by which firing data could be transmitted to the guns:

- (a) Simultaneously;
- (b) With a minimum loss of time in transmission;
- (c) In such a manner that both guns would receive the same data;
- (d) With a minimum of repetition incident to transmission;
- (e) In such a manner, that carelessness in, or illegibility of, written posting could be eliminated;
- (f) With a minimum of interference from the noise and shock of firing.

Another condition of the problem was the lack of public funds available for experimental purposes, and the consequent necessity of evolving apparatus and methods which could be created from material on hand.

*Whistle signals for drill and practice.*—The uselessness of cumbersome and involved commands led to the adoption of a set of signals given with the whistle furnished as part of the infantry equipment. These signals are as follows:

ONE SHORT BLAST: “Attention”, or “Posts”, if the section is not in action. “Silence”, or “Stand Fast”, if the section is in action.

TWO SHORT BLASTS: “Commence Firing”; or “Go Ahead”, if action has been interrupted.

ONE LONG BLAST: For each round to be fired.

These signals have been employed with success in several service practices, and were especially useful during battle practice, when, with the gun in battery and ready to fire, action was suspended incident to a change of target. Shrill blasts from a whistle can be heard above the noises usually present about a battery during firing, while they induce alertness on the part of the personnel, and increase efficiency of battery service to a marked degree.

*Modification of time-range board.*—The difficulty of accurately referring a point on a curve to a range scale some nine feet distant, is obvious; especially is this true when the range increments are 100 yards = 6 inches.

This feature detracts from the usefulness of the time-board described and ordered in Artillery Bulletin No. Serial No. 96, 1912.

Improvement in this device has been effected by plac-

ing the range scale on a movable vertical strip, so that it may be made to follow the curve as traced. The range scale slide is fitted top and bottom with a set of small barn door hangers, which run on tracks of light angle iron set on the top and bottom edges of the board. To prevent the scale from shifting during firing, it has been fitted with a spring bolt which catches



FIG. 1.

1235

Range slide, time-range board

in shallow holes bored in the face of the board along the center range line, at intervals of three inches. The modification above described in no way interferes with the method of operation as prescribed, and was effected at a total additional cost of \$1.40. A view of the board as modified, and details of the slide, are shown in Fig. 1.

*A hand tray for the powder charge.*—A study of the operation of ramming, in the loading of a major calibre gun on a disappearing carriage, indicated that the proximity of the rear portion of the truck to the leading ramming numbers induced a hesitancy of movement, and a consequent falling off of energy during the critical stage of the ram, resulting in a lack of uniformity in the seating of the projectiles. It was also noted that, in a number of practices, men apparently well trained would, in the excitement of firing, mishandle the powder charge, overthrowing it, or placing it on the truck tray awry, causing it to buckle in the breech recess, with a consequent annoying loss of time.

An important requisite of successful practice is the ability of the gunpointer to correct errors of deflection by observation with the sight at the instant of shot strike. Under normal conditions at battle ranges, this is extremely difficult, if not impossible, since at the end of the time of flight the piece cannot be traversed on the target, as the truck tray is then entered in the breech recess incident to the loading of the next round. This difficulty is overcome by the use of a hand carried tray for the powder charge, and a change in the prescribed method of manipulating the ammunition truck during loading. The tray is made of light wood, is 7 feet long, and 8 inches wide at the bottom, with side boards 8 inches wide set at such an angle as to make the width of the mouth of the tray at the top 15 inches. It is fitted with two cross handles nailed on the under side, and weighs approximately 30 pounds. It will hold two sections of powder and may be handled by two or four men, depending on the charge weight.

The operation of loading as now conducted at the battery is as follows:

The breech being open, the ammunition truck, carrying a projectile only, is brought up in the usual manner. As soon as the truck buffer strikes the face of the breech, the projectile is launched and rammed, and at the same instant the truck is withdrawn, or "cut out" to the left rear, leaving the breech clear for the leading ramming numbers. As the truck is clearing, the tray containing the powder is "edged in" from the left rear; as soon as the rammer head clears the breech on withdrawal, the nose of the tray is entered in the breech recess, the rear end swung around in prolongation of the piece, and both sections pushed into place in the powder chamber with one motion of the rammer.

During drill and service practice, the piece has been traversed continuously while being loaded, without interference or untoward results, which is impossible under the old system. (See last paragraph, page 30, Technical Notes, Coast Artillery Practice, 1910.)

The tray was constructed by the battery mechanic from

FIG. 2.

1234

waste material on hand at the post, and without the expenditure of funds. Its details, general appearance, and method of use may be seen in Figs. 2, 3, 4 and 5.

*Improvised firing sponge.*—In the last few years chamber sponges for major caliber guns have undergone several modifications; first, the change from the spring leaf type to one with

a solid wooden head; and, recently, the adoption of one in which the head was composed of an aluminum core with a felt filler. While the latter type is probably suitable for cleaning purposes in guns of the older models, it is too unwieldy for use as a firing sponge, and does not efficiently serve either purpose when used with the Model 1900 gun, in which the diameter of the gas check seat is considerably less than that of the powder chamber. The difficulty of properly clearing this gun is further increased by the presence, in the bottom of the powder chamber, of a fixed tray, whose edges form a pocket for the lodgement of smouldering debris, sometimes present in the chamber after the discharge of the piece.

FIG. 3.

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A firing sponge which does function properly in this type of gun was made by fastening twelve commercial scrubbing brushes to three spring leaves, "scrapped" from an obsolete type sponge, and mounting them on a light wooden handle. The leaf springs were so adjusted that the sponge would just enter the gas check seat, and expand against the wall of the chamber after complete insertion.

The sponge is not too heavy for one-man handling, thoroughly clears the powder chamber, is not difficult of construction, and has proved its usefulness in a number of firings.

Figures 2 and 6 show the general appearance and the details.

*Improvised powder charge.*—Since the resemblance between the issue dummy powder charge and that used in ser-

FIG. 4.

1236

vice practice is confined almost entirely to volume and weight, the poor policy of attempting efficient training with such means is evident, and a substitute was developed. The improvised charge was made by partially filling canvas covers for the issue dummy with wooden blocks of the same length and diameter as a powder grain, cut from moulding strips. The charge was

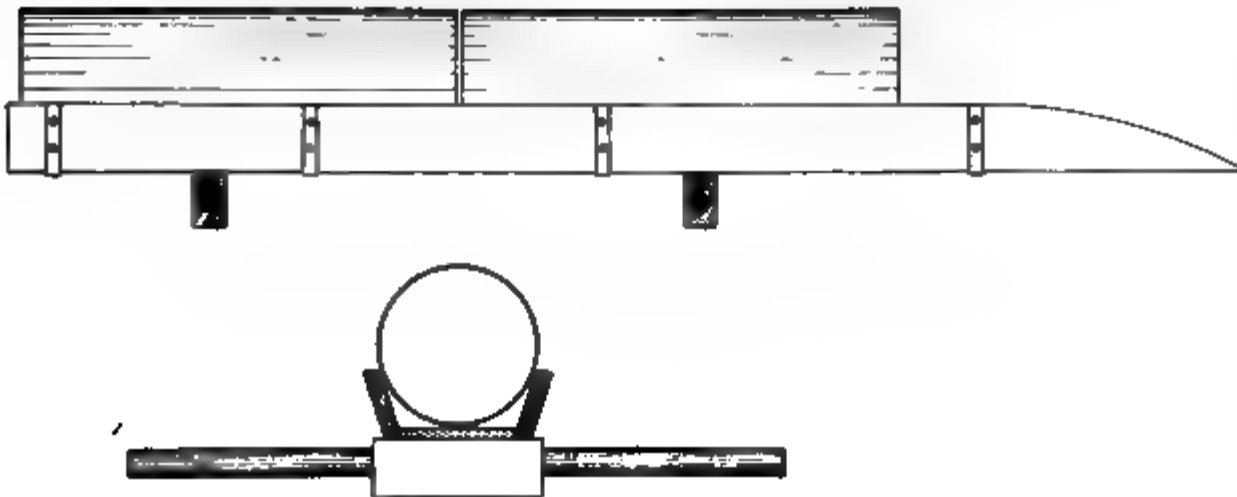


FIG. 5.

1237

Hand loading tray for powder

brought up to proper weight and volume by the introduction of a core composed of projectile points and other scrap. A convenient hold for the dummy extractor was made by drawing the tabs of the cover together and sewing in a piece of  $\frac{1}{2}$ -inch rope.

a s  
w  
fill  
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;  
v  
l  
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FIG. 7.

1229

FIG. 8.

1240

First stage of ramming. View taken just before truck buffer struck face of breech. Observe No. 11, who having guided truck to position, is caught turning to shove it to left rear. No. 12 is "set", ready to pull truck toward him and clear breech for the completion of ram.



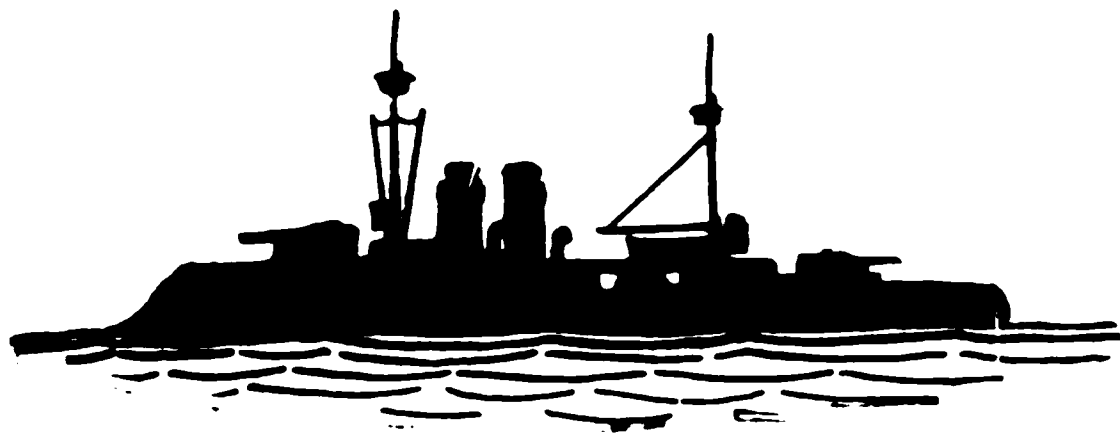
The slides of the gun boards are vertical and painted black, the left four being for range data with white figures, and the right three for deflection data with yellow figures; on one board these numbers increase downward, on the other board they increase upward. Each slide is weighted at the bottom with a piece of lead weighing 10 ounces, and fitted at top with a stout screw eye. Fastened to the screw eye and passing over a pair of screw pulleys, is a piece of buzzer wire which connects each slide of the gun boards with its control on the master board. The front of the board is fitted with a removable cover, fastened with four screw hooks, which admits of quick access to the slides in case of fouling, binding, etc., and conceals all data numbers except those shown through the slots. A view of a gun board is shown in Fig. 2.

The range officer, the plotter, and the deflection computer face the master board, and are thus able, and are required, to see that the firing data is set as called out. The system requires but one operator, who, after a few drills, is able to correctly exhibit range and deflection data in *plain figures* to the guns within ten seconds after the observation has been made.

The deflection data slides take the place of the deflection recorder and his board required by par. 768½, D. R. C. A.

All material used in the construction of the three boards was procured at the post without an expenditure of funds, except screw eyes and screw pulleys, which were purchased at a cost of \$2.85.

While some of the devices above described may appear crude, they are practical, and have been of benefit in the solution of some of the problems which confront the progressive battery commander in his efforts toward the attainment of efficiency.



# COAST DEFENSE IN THE CIVIL WAR\*

## FORT HENRY, TENNESSEE†

BY FIRST LIEUTENANT JOHN L. HOLCOMBE AND FIRST LIEUTENANT  
WALTER J. BUTTGENBACH, COAST ARTILLERY CORPS

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### GENERAL SITUATION

The Confederates in January, 1862, held a line from Bowling Green to Columbus, Kentucky, which was to bar approach from the north to the south, as well as to serve as a base for invasion of the north. The Union forces determined to begin operations by breaking this line, preferably in the center, and to make a "strategic penetration" of the Confederate lines.

### SPECIAL SITUATION

On January 29th, 1862, General U. S. Grant, inviting attention to the large force being concentrated in the district by the Confederates, and urging the feasibility of his plan, asked for authority to attack and hold Fort Henry, near the Kentucky-Tennessee line. He said that, if this were not soon done, the defenses on both the Tennessee and the Mississippi Rivers would be materially strengthened. From Fort Henry, it would be easy to operate either on the Cumberland, only 12 miles distant, on Memphis, or on Columbus. Besides, advancing them toward the Confederate States would have a great moral effect on the Union troops. This plan was agreed to by the department commander, General Halleck, on January 30th, 1862, it being directed that the troops be taken up the Tennessee, convoyed by Commander Foote and his gunboats.

### OPPOSING FORCES

Fort Henry was a closed earthwork, with bastion front, located on the right bank of the Tennessee River, comprising

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\* See note to "Coast Defense in the Civil War, Fort Sumter, S. C., (First Attack)," in JOURNAL U. S. ARTILLERY, for March-April, 1912.

† Though not strictly an account of an operation in coast defense, this account of the attack on Fort Henry is introduced at this point in the series of articles on "Coast Defense in the Civil War", in order to present in chronological order accounts of operations of guns afloat against guns ashore that took place during that war.

about ten acres. Fort Heiman, a small work, was across the river.

Fort Henry was built during January, 1862, and contained seventeen guns mounted on platforms, of which the following twelve\* bore on the river:

- 1 10-inch columbiad,
- 1 rifled gun, same caliber as 24-pounder gun, but firing 62 lbs. projectile,
- 2 42-pounders,
- 8 32-pounders,

all arranged to fire through embrasures formed by erecting between guns a parapet of sandbags carefully laid.

There were extensive lines of infantry cover in rear, holding commanding ground that would have been dangerous to the fort, if possessed by the enemy.

The lines and main work, being on the right bank of the river, and arranged with good defensive relations, rendered the position capable of offering a strong resistance against a land attack from the east.

All guns functioned well, except the columbiad, the recoil of which was excessive.

The ammunition on hand on January 18th was as follows:

10-inch columbiad	100 rounds.
32-pounder	782 "
12-pounder	274 "
24-pounder	100 "

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Total	1156 rounds.
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The artillery garrison consisted of one company of about 75 men.

There was great difficulty in getting competent artillerymen and there was not a sufficient number of artillery officers.

There was no ammunition suitable for the 42-pounders.

Fort Heiman was not in action.

Torpedoes were sunk in the chute of the river, at the foot of the island, but, due to lack of time and powder, none were placed in the main channel. All were rendered useless by a heavy rise of water.

The Navy had the following vessels in the action, organized in two divisions:—

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\* Editor's Note.—The official report of an officer of engineers states that twelve guns bore upon the river, but the reports of the line officers state eleven. One of the eight 32-pounders appears to be the gun that is differently reported.

*First Division*

Gunboat *Cincinnati*,

6 32-pounders,  
3 8-inch guns,  
4 42-pounder rifles,  
1 12-pounder howitzer.

Gunboat *Essex*,

1 32-pounder,  
3 11-inch guns,  
1 10-inch gun,  
1 12-pounder howitzer.

Gunboat *Carondolet*,

Same armament as the *Cincinnati*.

Gunboat *St. Louis*,

7 32-pounders,  
2 8-inch guns,  
4 42-pounder rifles,  
1 rifled howitzer.

*Second Division (old boats)*

*Conestoga*,

4 32-pounders.

*Lexington*,

4 8-inch guns,  
2 32-pounders.

*Tyler*,

6 8-inch guns,  
1 32-pounder.

The Federal forces available for the land attack are estimated to have been about 16,000 men; and the guns of the river fleet were 65. The Confederate force was about 2610 men and 11\* guns, *i.e.* guns of Fort Henry in action.

## NARRATIVE OF EVENTS

The attack against Fort Henry was made at 12:30 p.m. on February 6th, 1862, with four ironclad gunboats, the *Cincinnati*, the *Carondolet*, the *St. Louis*, and the flagship *Essex* in the first division, and three old gunboats, the *Conestoga*, the *Tyler* and the *Lexington* in the second division. The latter

\* Editor's Note.—The reports of the line officers indicate that only 9 guns were in action. The difference in the reports appears to have been due to the two 42-pounders' lacking proper ammunition, some of the reports not including them as in action for that reason, though they do appear to have been fired.

took a position astern and inshore of the armored boats, doing good execution there, while the armored boats were placed in the first order of steaming, and approached the fort in a parallel line.

Fire was opened from the flagship at 1700 yards range, the other gunboats following and the fort responding. When the boats, steaming slowly, had approached within 600 yards of the fort, their fire, as well as the fire of the fort, increased in rapidity and accuracy.

Twenty minutes before the close of the action, the *Essex* received a shot in her boilers, which resulted in wounding by scalding some twenty-nine officers and men, and caused her to drop out of line, entirely disabled.

Firing from the fort was kept up for a time upon the three gunboats that continued to approach, the fort's flag being finally hauled down after an action lasting one hour and fifteen minutes.

The United States flag was then hoisted over the works and the Confederate commander came on board the flagship and surrendered some 60 or 70 men, a hospital boat with 60 invalids, and the fort and its effects, mounting about 20 guns and having barracks and tents capable of accommodating approximately six thousand men.

Taking up in detail the operations in the fort during this attack, the official report mentions among other things:

A short time after the engagement began, a rifled cannon burst, killing three men and disabling some others. This impaired very much the morale of the troops serving the guns, both because of the "gun-shyness" created and because of the doubt entertained as to the ability of the remaining guns, all unrifled, to do effective work.

From the rear of the line of four armored gunboats, a wooden gunboat was using curved fire, striking the parapet, but in no case penetrating to the interior of the fort, unless the cheek of an embrasure was struck.

One of the 32-pounders was struck by a shell passing through an embrasure, all of the gunners at the piece being disabled and the gun rendered unfit for service.

At about the same time, a premature discharge occurred at one of the 42-pounders, causing the death of three men and seriously injuring others.

Next, the 10-inch columbiad was out of service, the primewire having jammed and broken in the vent, virtually rendering the piece.

By this time the gunboats had approached to within 600 or 700 yards of the works.

The men now becoming discouraged, as they saw the boats approaching nearer and nearer, they even stopped working the 32-pounders, believing their shot were too light to produce any effect on the ironclad boats.

After firing had continued for about an hour and five minutes, only two guns in the fort responded to the fire of the gunboats, whose shots were telling with effect on the parapet.

Effort was made to get men from outside the work to man the guns, but it could not be done.

General Tilghman, the Confederate commander, then sent instructions to the commanders of the troops in the exterior lines to withdraw with their forces, which was done, the retreat being along the road to Fort Donelson. Of the approximately 2600 men the Confederates had in the vicinity of Fort Henry, fewer than 100 were surrendered, the larger force getting away while the small garrison in the fort fought, as it were, a delaying action covering the retreat.

On surrendering, General Tilghman stated that all his guns except four were out of action, he having commenced the action with eleven against the fleet.

The Confederate garrison, on the 6th of February, consisted of actually 2610 men, only one third of whom were either well armed or disciplined, while the fort could be enfiladed from three points on the west bank. Under such conditions news arrived that General Grant with 12,000 men was moving up the east bank, and General Smith with 6000 up the west bank. The position not being deemed tenable nor as important as Fort Donelson, and the garrison being urgently needed to reinforce Fort Donelson, at 10:15 a.m. the infantry, the field artillery, and the cavalry, fell back on Donelson, a company of heavy artillery manning the fort to cover the retreat of the main body. So when the fleet commenced the attack, the fort was overmatched both as to troops and as to the number and caliber of guns. The main object of the garrison of the fort was to gain time for the retreating main body, and with that object the fight was maintained for more than an hour. Though the surrender was made to Flag-Officer Foote, by his direction the fort was turned over to General Grant, who arrived on the scene about one hour later.

The plan of the attack had been for the army to attack the rear of the fort simultaneously with the naval attack from

the river; but the land attack was prevented by the excessively muddy roads and by the high stage of the water, which prevented the arrival of the troops until some time after the surrender.

When the fort had surrendered, the fleet withdrew, returning to St. Louis.

### CASUALTIES

#### *Cincinnati:*

Killed	1
Wounded	9

#### *Essex:*

Killed	1
Scalded	38 (of whom 13 died later).

#### Fort Henry:

Killed by enemy	2
Seriously wounded (1 dying)	3
Slightly wounded	2
Killed by premature explosion	2
Seriously wounded by premature explosion	1
Slightly wounded by premature explosion	1
Temporarily disabled by explosion of gun	5
Missing	5

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Total	21
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#### There were surrendered:

Officers	12
Men	66
Men in hospital	16
Guns, munitions of war, etc.	

The <i>Essex</i> was hit	15 times
The <i>Cincinnati</i> (flagship)	31 "
The <i>St. Louis</i>	7 "
The <i>Carondolet</i>	6 "
The <i>Carondolet</i> fired	107 shells
The <i>Essex</i> "	70 shots
The <i>St. Louis</i> "	107 "

The <i>Lexington</i> fired	37 shells
The <i>Conestoga</i> "	75 32-pounder shell
	14 12-pounder shell
	2 12-pounder shot.

The armored casemates effectually resisted the shot of the enemy, and their formation, bow on, presented an unfavorable target to the land gunners.

#### COMMENTS

1. Lack of personnel to work the guns properly, caused the men to be worked to the point of exhaustion.

2. Reinforcing artillerymen during progress of action, found impossible.

3. Effect on the morale of artillerymen, of seeing their fire unable to stop the enemy's approach.

4. Part of armament (the 42-pounders) with no ammunition.

5. Failure of the joint operations on part of the Federal forces, making it possible for the greater part of the Confederates to escape.

6. Preponderance of fire of gunboats over that of fort.

7. Guns of gunboats were served more quickly, of greater caliber, and better ballistic properties.

8. Protection furnished gunners on the boats, far superior to that furnished the personnel of the fort.

9. Damage to material in fort put several guns out of service.

10. One of the earliest recorded occasions on which submarine mines were used in aid of land defense.

11. An example of an artillery duel at extreme short ranges.

12. Attack formation of gunboats adopted, afforded minimum of target to Confederate fire, but also minimum number of guns bearing on works.

13. Change in naval tactics in attacking works, as compared with those previously seen.

14. Use of curved fire by supporting gunboats firing over leading line of boats.

15. Determination on part of the navy to close in to shortest ranges, as seen in action of gunboats, no long range bombardment being employed.

16. Fire from gunboats wild till within 1200 yards range.

17. Fire of the forts with-held till boats were within 1600 yards range.



18. Confederate fire rather more effective as to hits than usually the case, obtaining high proportion of hits, for ammunition expended.

19. Example of delaying action, covering a retreat.

#### AUTHORITIES

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The Gulf and Inland Waters (The Navy in the Civil War series), pages 22-24.

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# PROFESSIONAL NOTES

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## MANUFACTURE AND TREATMENT OF STEEL FOR GUNS—I\*

AN INDUSTRY OF ABOUT THIRTY YEARS STANDING

By General L. Cubillo

### INTRODUCTORY

It is about thirty years since steel was definitely adopted by the chief countries of the world for gun construction. The many difficulties presented in the manufacture of large homogeneous masses of steel, and the resistance offered by tradition and routine to every change in industrial processes were the chief causes of the continuation of the use of cast and wrought iron, in the third quarter of the last century, if not for the whole construction, at least for the principal elements of guns. The celebrated American artillerist, Rodman, cast large caliber guns, of cast iron exclusively, and applied, during and after the casting process, his invention of cooling the inside of the gun with water, and of heating the outside in such a manner that the inside was compressed by the outside. By this the maximum tangential resistance of a single tube is attained, and it is then best fitted to oppose the pressure of the powder. The metal used by Rodman in the manufacture of guns was of a quality which has not since been surpassed. The pig iron employed was charcoal and cold blast iron, from ores of the greatest purity, so that the resulting cast iron possessed the best mechanical qualities. The resistance of cast iron guns was certainly increased by the Rodman process, though it was not known exactly by how much, since it is impossible to apply the rules of shrinkage to guns treated as described. But the improvement so obtained was not sufficient for the requirements of the artillery, and cast iron, whether alone or combined with wrought iron or puddled steel, was incapable of withstanding very great pressure. It was certainly possible to fire the guns so constructed with charges larger than those employed in ordinary cast iron guns, but the difference was not great, since a very considerable part of the gun was made of cast iron, the mechanical properties of which are deficient as compared with those of wrought iron and steel. In France and Spain a combination of steel, wrought iron and cast iron was tried, the first metal being employed for that part of the bore where the pressure is greatest, but this combination, which actually produced guns more powerful than those made of cast and wrought iron, was abandoned since, owing to the progress of metallurgical science, the manufacture of steel in large masses had now become possible. The guns made of this triple combination were capable of withstanding a pressure of 2200 kilograms per square centimeter. It was necessary to use quick-burning powders in them, because the steel tube

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\* Reproduced from *The Engineer*.

not being of the total length of the bore, the gun at the cast iron end was much weaker and incapable of withstanding great pressure. It is, therefore, easy to understand why, as soon as it became possible to cast great masses of steel, this metal, with its greatly superior physical and mechanical properties, was exclusively adopted for the construction of large guns. It will always be a distinction, however, for the Krupp works to have been the first to cast great masses of steel, while the Bessemer and open-hearth processes were still unknown to the metallurgists, but the method by which Alfred Krupp achieved his wonderful results is so well known that it need hardly be described here.

#### I. CONDITIONS OF THE STEEL REQUIRED FOR GUN CONSTRUCTION

If it were possible to produce a metal at low cost such that it possessed a high elastic limit, and also high tenacity, great ductility, and resistance to the wear produced by the powder gases at great pressure and high temperature, with, moreover, a very high melting point, such a material would undoubtedly be the most suitable for the manufacture of guns. The very great pressure which the material must withstand is not, it is true, of great duration or of great frequency in large and medium-sized guns; but it is necessary to take into consideration the fact that what causes this enormous pressure is the highly heated gases, which exercise both a physical and, in a certain portion of the bore of the gun, a chemical action on the metal. As has already been said, steel has been adopted as the only material suitable for guns. But steel offers so great a variety of types, that it becomes necessary to select from among these one which possesses in the highest degree the conditions already laid down. If the steel is ordinary carbon steel, its high elastic limit is accompanied by a high tenacity and less ductility than that which accompanies a metal of smaller elastic limit and tenacity. The resistance of the former metal to dynamic stresses will be less than that of the second, and its melting point will also be lower. The gun makers have universally adopted a metal between the dead soft and the hard steels, namely, an iron-carbon alloy, tending rather toward mildness, due specially to its high melting point. This last property is now very important on account of the use of the modern smokeless powders, and especially the nitro-glycerin powders. The high combustion temperature of these powders, and the incomplete obturation of the driving band of the projectile at the commencement of its travel in the bore of the gun, is the origin of what is called erosion in the bore. The modern experiments of Vieille and some others made at South Bethlehem, not to mention the earlier ones made by Sir Andrew Noble, have demonstrated without doubt that the mild steels are better able to withstand the effects of erosion, because, among other properties, they possess melting points higher than those of the hard steels.

An ordinary carbon steel for guns has about 0.5 per cent of carbon, and its place in the iron-carbon solution is in the series of the metals called steels, having a carbon percentage of less than 2 per cent. The characteristic of this series is that it is not eutectic at its freezing point, and that it presents a similar phenomenon in the subsequent cooling, when it arrives at the point *A<sub>r</sub>* in the cooling curve. All this refers only to the ordinary carbon steel. The ternary alloy of iron-carbon and nickel or the quaternary alloy of iron with carbon chromium and nickel is employed in the manufacture of medium and small guns only, because the cost of such an alloy would be prohibitive

in the construction of the larger ones, especially now that the principle of uniformity of caliber has been adopted by all the navies of the world. It must be said, however, that the *A* and *B* tubes for the great 16-inch experimental gun manufactured in the United States are of nickel steel. In adopting this alloy for the construction of guns it has been necessary to diminish the percentage of carbon, because if it reached that of ordinary carbon steel with percentages of 2.5 to 3.5 per cent of nickel the steel would be very hard, that is, it would be what Mr. Guillet calls "martensitic steel."

*Mechanical Tests.*—It is not necessary to give here a complete table of the specifications for gun steel as required by the armies and navies of the European and American powers. In all the specifications two different kinds of mechanical tests are required; in the one case, that of continuous and progressive tension up to the yield point, together with the measurement of the elongation after breaking; while the other test consists in subjecting the test piece to a certain number of impacts according to details and conditions fully specified, or, perhaps, to some bending test, equally fully specified. If the steel has been manufactured from pure materials, such as the best Swedish pig iron and from scrap from the puddling of the best hematite pig iron, and if it has been carefully cast, forged, annealed, hardened and tempered, the tensile tests are quite sufficient in the author's opinion; while the close examination of the forgings during machining will, conjointly with the tensile tests, also convey a good idea of the quality of the metal, so that the impact or bending tests can be dispensed with. But perhaps it may happen that the best treatment has not been properly conducted, and that the metal which withstands the tensile tests may fail in the impact tests. The latter are those which give a really good idea of the brittleness of the metal. Many years ago these mechanical and bending tests were introduced into the specifications for ascertaining the presence of phosphorus in the steel. It is possible that a metal with a high percentage of this metalloid may give satisfactory results in the static tensile tests, and that the yield point and the ductility may be very good; but this steel would certainly withstand far fewer impacts than a very pure steel. Indeed the tests, which a metal suitable for gun construction must undergo, must produce stresses similar to those caused in the gun by the powder gases. This metal, when the gun is composed of a single tube, as is generally the case in mountain guns, passes, in an infinitesimal space of time, from the state of repose to a strain of two thirds at least of its elastic limit of static tension; and when the gun is a composite tube the concentric layers of some of its elements pass in an equally short space of time from a state of compressive stress to another of tensile stress, both of which are opposite states of stress of considerable importance. Taking into consideration both the opposite stresses to which the elements of the guns are subjected, before and under fire, perhaps the best mechanical test for gun steel would be that of alternating stresses with considerable variation, these stresses being repeated a certain number of times in harmony with the rounds fired by the guns. The shock tests are now universally accepted, as has been said, in order to ascertain the fragility of the metal. The resolutions of the last congress of "Les Méthodes d'Essai des Matériels" assembled at Copenhagen recommend a shock test with test pieces, together with a slight nick in one of the long sides of the piece. Certainly this test must be adopted as one of the means of ascertaining the good quality of gun steel.



## II. MELTING OF THE STEEL

Of all the processes employed in the melting of steel the only ones used in the manufacture of gun steel have been the crucible and the open-hearth processes. The first process was naturally employed before the introduction of the open-hearth method, and for some time afterward; but the latter has now superseded the crucible process, except at the Krupp works.

Mention has already been made of the great claims possessed by this firm as the pioneers in casting, by the crucible process, great masses of steel intended for gun construction. Credit must also be extended to the English firms of Firth, Vickers and Whitworth, which also employed their energies in the improvement of this manufacture. The firm of Krupp has always claimed that the crucible process offers the best guarantee for a sound metal for gun construction. Undoubtedly it is possible to obtain by it a metal of greater purity with regard to phosphorus and sulphur than by any other process, if the material charged in the crucibles is wrought iron from hematite pig iron. The metal obtained in this case will be the best possible steel, and it will not contain occluded gases; or at all events in very small proportion. If the metal charged in the crucibles is free from oxides, the only gases dissolved in the steel will be those which have passed through the walls of the crucibles.

In the author's opinion steel made by the crucible process must lack homogeneity, because it is almost impossible that the composition of the charge of all the crucibles will be the same. It is also impossible to secure uniformity of composition in the ingot mold, bearing in mind segregation. The only way of securing homogeneity by this process would be to teem the crucibles first into a hot ladle, and then into the ingot mold. The principal reason for this lack of homogeneity lies in the impossibility of analyzing all the puddled bars which form the charge of the crucibles, classification by the eye being very uncertain. Therefore, in the author's opinion, a massive ingot of steel cast by the crucible process is more heterogeneous than a similar ingot cast by the open-hearth process. The open-hearth acid process is generally employed for the casting of great masses of steel. The basic process can, of course, be employed, provided the materials charged are acid; and there is no difficulty in obtaining by the open-hearth process, that is, by the dissolution in a cast iron bath of a certain quantity of wrought iron or steel, a very pure metal, such as is required in the construction of guns. All depends on the purity of the pig iron and scrap charged.

It is the constant practice of all the steel works where steel for gun construction is regularly made to employ Swedish pig iron of the best quality, the phosphorus being as low as 0.025 per cent, and the sulphur lower than this amount; and for the scrap, puddled balls or bars from the best hematite pig irons.

By puddling this pig it is possible to obtain a product with phosphorus and sulphur as low as 0.001 per cent, and as furnaces of 50 or 60 tons capacity are now very common, and as for the casting of the largest element of the new great guns it is not necessary to have ingots of more than 100 or 120 tons, the result is that it is not very difficult to obtain a great uniformity of the metal by this process. The conditions of open-hearth working permit of working two or three furnaces so uniformly that, at the time of casting, the metal of the two or three furnaces will be perfectly similar. The steel is much exposed to the oxidation of the furnace gases, always in contact with

the bath; and to this action is added that of the iron ore incorporated for oxidizing in a rapid and energetic manner the silicon and carbon in excess of that required in the steel. There are many means of diminishing the oxidation of the bath; one of them is to prepare the charge by putting in the furnace the greatest possible amount of scrap, with the smallest quantity of carbon, and conducting the refining process by the furnace gases only without the addition of any iron ore. This particular method of working is extraordinarily slow; first, because, as the materials, both pig iron and slag, are charged at once and cold, the mixed bath is very low in carbon and its melting point very high. It therefore requires more time for melting it than if the charge had been composed of equal parts of pig iron and scrap. Secondly, because the oxidation of the carbon by the gases is not so efficacious as that by the iron ore, this being more in contact with the bath and the former acting only on the surface. Operating in this way the final steel is almost free of oxides, and in order entirely to eliminate them additions are made, at the end, of certain iron alloys, such as ferro-manganese and ferro-silicon, which by their action upon the bath reduce the iron oxides dissolved in it. This addition is the more required when the charge has been of equal parts of pig iron and scrap. The percentage of carbon of such a charge at the fusion or melting time will be very high, and it is not possible to oxidize the excess carbon to the point required in the artillery steel by the action of the gases only, and it is almost imperative to employ the iron ore for accelerating the oxidation of the carbon.

*Fusion at Trubia of the Ordinary Carbon Steel for Guns.*—The steel works at Trubia comprise two furnaces—one of large capacity, capable of taking charges up to 54 tons, and the other of 16 tons. Therefore, it is possible, working with the two furnaces to obtain an ingot of 64 tons. The furnaces were supplied by Messrs. Frederick Siemens, of London, and are of the usual design. They are situated in a straight line, with a very commodious working platform, and are served by an electric charging crane, of the well-known Wellman type. For the service of the casting shop there are two overhead electric travelling cranes, one of 75 tons capacity, with one motor only of 30 horsepower, and the other is a Niles 50-ton capacity crane, worked by four motors of 130 total horse-power. The second crane, of course, has been more recently installed than the first. In the fusion of the ordinary carbon steel for guns, the materials employed are Swedish pig iron and puddled ball from Bilbao hematite pig iron. In order to convey an idea of the operation a heat in the 16-ton furnace will be described.

The furnace was charged with 7.5 tons of Swedish pig iron and 9 tons of puddled ball from Bilbao hematite. These materials were charged straight into the furnace, the first charged being the pig iron. At 9:2 a.m. the charge was commenced, and melted at 2:40 p.m. The first iron ore addition of 60 kilogrammes weight was made at 2:50 p.m., and another of the same weight at 3:15 p.m., followed by another of 50 kilogrammes at 3:35 p.m. During the melting period and the following forty-five minutes nearly all the silicon was oxidized. Some minutes after the third iron ore addition, the ebullition of the bath commenced, which evidently proved that the oxidation of the carbon was energetically proceeding. The iron ore additions followed from time to time as the state of the bath indicated the necessity. The operation was conducted with the air valve closed as much as possible, so that the metal should not become cold, nor become oxidized. The total additions of iron ore amounted to 350 kilogrammes. At 6:25 p.m. the calorimetric analysis

of the small sample taken from the bath and very slowly cooled gave a percentage of carbon of 0.52 per cent, and as the quantity required in the steel must be between 0.45 and 0.55 it was decided to tap the furnace, making previously the suitable additions of alloys. These were ferro-manganese

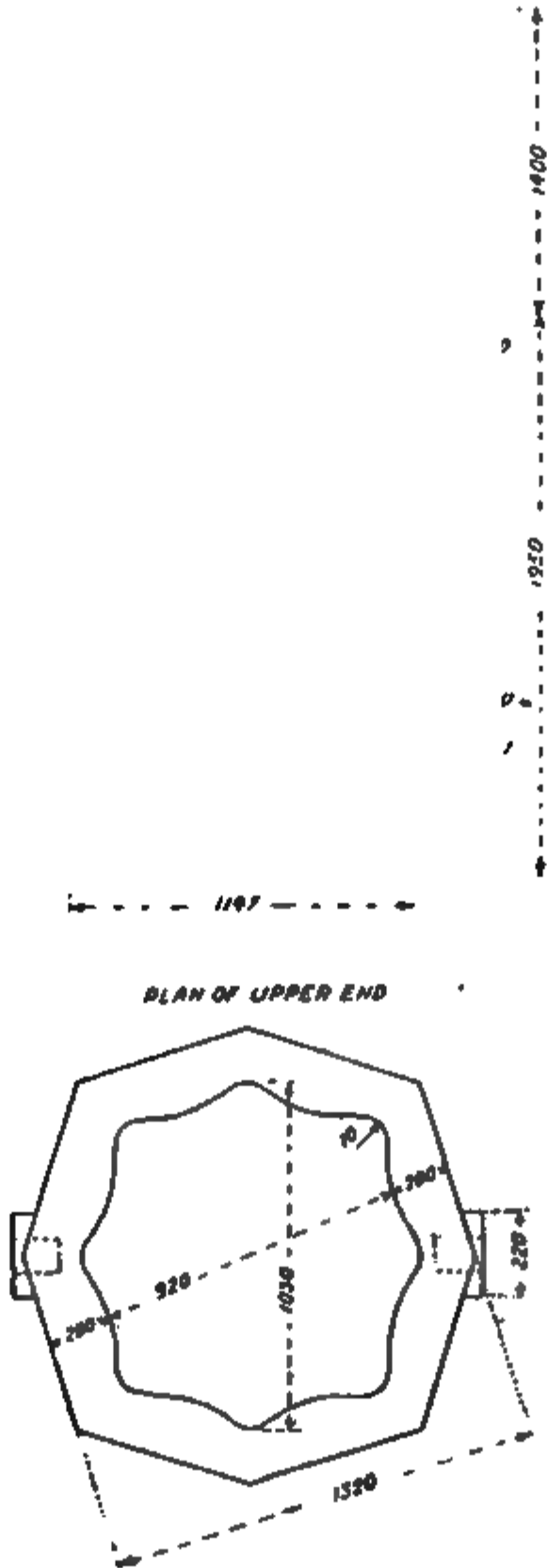


FIG. 1.

1201

Ingot mold

and ferro-silicon, putting 121 kilogrammes of the first and 99 kilogrammes of the second. The percentages required in the metal were 0.55 to 0.65 per cent of manganese and 0.15 per cent of silicon. This percentage is quite

sufficient for obtaining a metal totally free from side and central cavities, except those at the top of the ingot, and the pipe. The metal is poured into a Wellman ladle, previously well heated by producer-gas. The ladle is then transported by the 50-ton electric crane to the casting pit, where the metal is poured into the mold.

*Ingot Mold.*—This is of cast iron, with a wash of refractory material, intended to retard the cooling of the metal at the top, keeping it fluid as long

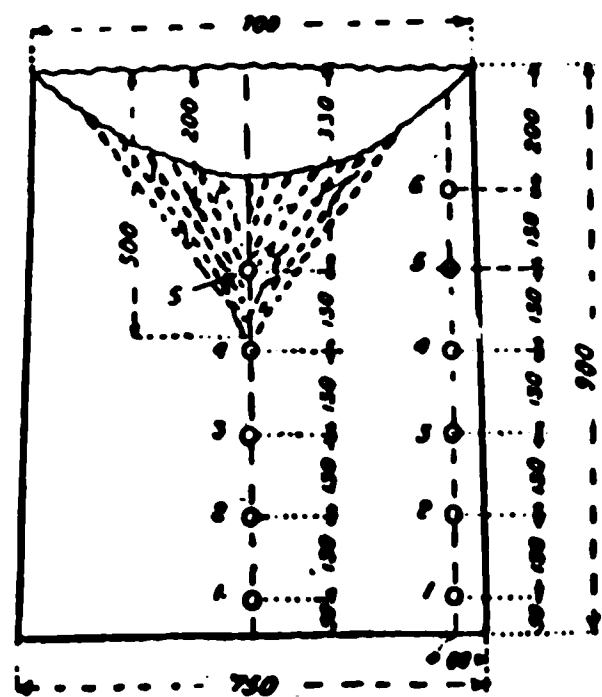


FIG. 2. 1242

Portion of ingot sampled (See Table)

Center				
No.	Carbon per cent.	Manganese Per cent.	Silicon Per cent.	Phosphorus Per cent.
1 .....	0.565	0.525	0.187	0.024
2 .....	0.672	0.610	0.210	0.029
3 .....	1.176	0.620	0.230	0.029
4 .....	1.607	0.620	0.261	0.036
5 .....	2.484	0.610	0.284	0.049
Outside Surface				
1 .....	0.564	0.595	0.187	0.021
2 .....	0.463	0.580	0.187	0.018
3 .....	0.565	0.570	0.187	0.017
4 .....	0.427	0.575	0.187	0.017
5 .....	0.443	0.565	0.187	0.018
6 .....	0.497	0.585	0.163	0.019

*Analysis of Small Ingot Taken During Pouring*

	Per cent.
Carbon .....	0.562
Manganese .....	0.766

as possible, so that it may fill the space left vacant by the contraction of the metal in the rest of the mold. The mold, both outside and inside, has the form of a truncated pyramid—see Fig. 1. The sides of the inside pyramid, instead of being plane are curved surfaces joined to one another by rounding

the edges. It seems natural that, since the elements of guns are cylindrical, the ingot molds should also be of cylindrical form inside, and since also the steel, as it solidifies, crystallizes in crystals whose axes are normal to the surface of the mold, the cylindrical form should be the best for obtaining good sound ingots without cracks. The reverse is what happens. The ingots cast in circular metal molds have always a deep longitudinal crack, and thus are incapable of subsequent forging. In order to avoid the occurrence of cracks during solidification and subsequent cooling on the outside surface of the ingots, they are sometimes cast in refractory molds. But though no cracks occur in ingots cast in such molds, the long time spent in the cooling of a large ingot, cast in such manner, produces a very coarse crystalline texture, almost impossible of being changed to the proper texture during the forging. The experience at Trubia with 40-ton ingots cast in refractory molds has been totally adverse to their use as substitutes for metal molds for the part of the ingot really utilized. When this is completely solidified and almost cold on its outside, it is taken out of the mold and is covered with ashes until it is completely cool. After this it is carefully examined for cracks, which are dealt with by the pneumatic hammer. As it is not an easy matter to get rid of them entirely by these means, the ingot is sent to the forging shop, where it is subjected to a slight preliminary forging, just sufficient to give it a cylindrical form. Any cracks which were not visible in the preliminary examination then appear, and are taken out in the lathe. Some very good metal is thereby lost, but in the finishing up of the forging no cracks appear, and it is possible to finish the pieces with the least possible excess in the dimensions required for the hardening.

Before describing the forging, it may be mentioned that, about half way through casting, operations are suspended for an instant, while a very small ingot is cast from the ladle. This is intended for the full analysis of the metal, and for forging a test piece for a preliminary tensile test. In order to study the segregation phenomena in the unfinished steel, the head from a 16-ton ingot was divided through its vertical axis. One of the halves of this head is represented in Fig. 2. From it were taken the samples for analyzing the carbon, manganese, phosphorus and silicon. The samples were taken only in one half of the head, because it was presumed that the symmetrical parts of the other half must have the same composition, as the conditions of cooling were equal for both halves. The small ingot taken during the casting operation, which, owing to its very small dimensions, is free from the phenomena of segregation, and fairly represents the composition of the steel in the ladle—where it is supposed to be completely homogeneous—gave on analysis 0.56 per cent of carbon and 0.57 per cent of manganese. On comparing these percentages with those of the samples it is observed at once that there is not a very great difference between the samples taken at the circumference of the head and those of the small ingot. But the difference is very great in the samples taken in the center of the head. Here, segregation phenomena are in evidence, especially with regard to carbon. It is observed that sample No. 1, from the bottom of the head, has the same quantitative composition as the metal of the small ingot, but in samples Nos. 2, 3, 4 and 5 the percentage of carbon increases gradually, being in sample No. 5 four times greater than in sample No. 1. The manganese increases also, but less so; the silicon more than the manganese, while the phosphorus in sample No. 5 is double that of No. 1. The layer of steel, in contact with the ingot mold, represents very nearly the composition of the metal; in fact, the percentage of the met-

alloids is less. The layer successively cooling from the outside yields to the inside layers a certain part of its metalloids until the central part of the ingot is reached, which, being the last to solidify and cool, is therefore richer in foreign elements. As the ingot mold is not closed, and is not in the form of a symmetrical cube, the segregation phenomena do not occur in the ordinary ingot mold in the manner described by Howe in his classical book, "Iron, Steel and Other Alloys," as the "Onion type" of freezing. If the mold is a perfect cube, and the action of gravity be assumed to be counterbalanced, the segregation phenomena should occur in a completely regular manner, in layers parallel to the sides, and the metal richer in foreign elements will be exactly in the center of the figure. In the casting of large ingots the segregation phenomena must occur as described, because the top of the ingot is the last to cool, especially if, as in the case at Trubia and elsewhere, the head of the mold is of refractory material, which contributes, to a great extent, in keeping the metal fluid longer than if this part of the mold were of metal.

About twenty years ago Brustlein explained, in a report to the "Commission des Méthodes d'Essai des Matériaux" in 1892, the lack of homogeneity of steel ingots and segregation phenomena in a manner very similar to that already explained in this paper, but without the aid of chemical analysis. His views as to segregation phenomena are in perfect accord with the manner of solidifying the iron-carbon solutions, as Roozeboom has explained in his diagram.

Applying their theories to the solidifying of steel ingots for gun tubes, it is easy to explain why the percentage of carbon increases from the outside layer in contact with the walls of the mold to the center of the ingot, culminating in the greater amount of carbon and of the other foreign elements in the upper and central part of the ingot which is the last to set.

*Fluid Compression.*—Fluid compression consists, as everyone knows, in applying pressure to the steel while still fluid or semi-fluid. The process has acquired considerable development, and is extended to ingots of common steels, whereas it was at first only applied to ingots intended for the manufacture of guns or for the large shafts of ships. The older fluid compression method is that of Whitworth, whose patent was taken in 1866, the chief object of which was to obtain cast steel ingots free from cavities. The Whitworth process is undoubtedly a very good one, and, considered economically, it offers great advantages, but in practice not all the advantages of fluid compression are obtained. In one of the most important French steel works, where this process is applied to the ingots intended for the construction of guns, the author has had occasion to examine some of them and has found that the pipe at the top does not entirely disappear.

In order to demonstrate that the Whitworth fluid compression process gives homogeneous ingots—that is, ingots free from segregation—it would be necessary to demonstrate it practically by dividing a large ingot longitudinally, and taking many samples for analysis, from all parts, or at least in the upper third. It is certain that in present-day practice, with the judicious use of deoxidizing alloys in the furnace such as ferromanganese and ferro-silicon, and perhaps with a very slight addition of aluminium during the casting operation, it is possible to obtain ingots free from cavities, except at the very top, in the central part, as is seen in the head of a 16-ton ingot, represented in Fig. 2. In this, as in all similar ingots, a very sound and homogeneous—78 per cent—total mass was obtained. In favor of fluid compression it may be said that it causes the disappearance of the deep cracks, especially

in the bottom of the ingot. Perhaps this is to be attributed rather to the lining of the inside of the ingot mold with refractory material. The cracks are always a serious defect, and sometimes, if ingot molds of polygonal section without rounded corners are employed, and the block, after forging, is put on the lathe, they appear as dark lines along the total length of the piece, which correspond to the angles of the ingot. Certainly, in many cases the turnings do not break off when the tool cuts across the dark lines, but all the same the appearance of such lines does not suggest a very good quality of metal.

With regard to the improvement of the mechanical properties by fluid compression, the author must say that it is not very evident to him. Perhaps it is assumed that fluid compression during the last period of the process, when the metal is in a semi-fluid state and almost set, confers an effect similar to forging. In Whitworth fluid compression, after the expulsion of the gases, the press does not cause any deformation in the ingot, and there cannot be forging without deformation. Some years ago a new fluid compression process was patented by Messrs. Robinson and Rodgers, of Sheffield, in conjunction with Mr. Illingworth, of New York. This process has been described by Mr. A. J. Capron.\* The advantages derived are that absolutely sound ingots are obtained free from cavities and pipe, so that the whole of the ingot can be utilized, without any waste. As it is possible to watch, during the compression, the top of the ingot and the setting of the liquated part of the steel, a great improvement in the quality of the metal can be obtained. The ingots are poured in the same place as they are compressed. The plant is very simple and economical, and can be operated by men without special training, and, the ingot molds being in halves, the top and bottom sections are equal, which facilitates the rolling.

Another compression fluid process, which has become very well known and accepted during the last years, and is widely adopted in France, England, and Germany, is that patented by Mr. Harmet, of St. Etienne, which has also been fully described by him to the Iron and Steel Institute.†

In concluding this part of the paper, the author would repeat that, in his opinion, the principal advantage to be derived from fluid compression lies in its economical aspect. When casting under ordinary conditions, it is possible to utilize from 75 to 80 per cent of the ingot, while with compression it is possible to reach 90 per cent.

(To be continued.)

—*Scientific American Supplement.*



## THE APPROACHING CHANGES IN WIRELESS PRACTICE

Wireless telegraphy has always appealed to the imagination of the layman, and several things have occurred during 1912 to keep the matter before his attention even more prominently than usual. On the purely technical side there are many new and interesting developments. We are concerned mainly with the strictly electrical phase of the subject. The generator of the future will be an entirely special machine, inasmuch as its speed will be many times greater than the speed called for by the requirements of all

\* *Journal of the Iron and Steel Institute*, 1906, No. 1, page 28.

† *Journal of the Iron and Steel Institute*, 1902, No. 11, page 146.



standard electrical service. A few years ago an alternator which could produce current at a frequency of, say, 200,000 cycles a second was regarded as an utter impossibility. Its existence is now an accomplished fact. Mr. Alexanderson's article\* \* \* \* describes his high-frequency alternator in considerable detail; and the result of his work during the last few years on this very intricate engineering problem will probably be fraught with great consequences to the future of wireless telegraphy and telephony.

The ability to produce continuous trains of waves of high frequency (say, 40,000 cycles a second and upward) will mean eventually the entire supersession of the spark-gap method now commonly employed. The *New York Times*, for October 6th last, contained an article on this very subject. To show the commercial significance of this part of Mr. Alexanderson's work, we will quote:

According to Prof. I. Pupin, of Columbia University, wireless telegraphy is about to make some phenomenal advances. The professor believes that instead of the spark-gap method, of sending out oscillations there will be used instead powerful high-frequency electrical generators. To the layman this gives no hint of the tremendous importance of the step, but the student of wireless progress and development sees in it the promise of vast improvement. He foresees the transmission of wireless messages at all times and in all weathers, and a new independence of atmospheric conditions. He foresees messages sent a far greater distance than at present, and far more easily. He foresees the removal of many of the most besetting difficulties of wireless telephony. Above all, he foresees wireless brought down nearer to the level of its ultimate desire, the ordinary level of the ordinary telephone—the "foolproof" level.

When reviewed recently Prof. Pupin explained that it was originally felt necessary that the oscillations for wireless transmission should be of very high frequency. The oscillations in wireless telegraphy are the aerial vibrations sent out from the transmitter of a wireless station, to be caught by the receiver of a station within the radius of the waves produced. At the outset the operation called for as many as a half-million or a million oscillations a second—high frequency such as only a spark-gap could produce. These were necessary for any great distance work, and yet there were difficulties involved in their use. Such high oscillations are constantly lost in sun-lit air, and, furthermore, besides being dependable on the weather, they are as discontinuous and irregular as the spit-spit of the crackling spark-gap itself. Gradually, by such experimentation as is afforded only by the practical, commercial use of wireless, it was learned that messages could be sent across the water with a far lower frequency oscillation, as low as from twenty to forty thousand a second. This was recently announced by Mr. Marconi himself, and with the announcement the electricians rose and said: "If you can use oscillations of as low a frequency as that for wireless, than we can make you powerful dynamo-electric generators that will produce them. You will no longer have to depend on the spark-gap with its intermittent explosions. We will give you a powerful high-frequency machine that will send out a continuous,

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\* See *General Electric Review*, January, 1913.



smooth train of oscillations and yet will have a hundred horse power to drive them as far as you wish."

We may note again that these high-frequency alternators for the generation of smooth continuous waves have been developed for frequencies far in excess of the 40,000 cycles mentioned in the extract. Already machines for 100,000 cycles and 200,000 cycles have been built; although these, of course, have been machines of relatively small capacity, for use in stations of small output for long-distance work, and there may be a greater market for machines of the lower frequencies (30,000 and 40,000 cycles) built for greater capacities.

"And when that was made possible," said Prof. Pupin, "the practical problems of wireless were greatly simplified. For sending by slow oscillations is practically independent of the weather. The slow, continuous oscillations sent out from a 100 h. p. machine will go through any kind of atmosphere. The sunlight, which disintegrates the constituents of the air and destroys its capacity as a non-conductor, is ruination to the high-frequency oscillation, which calls for rain and cloud and darkness. The demands are just the reverse of those of the sailor's. The weather for ships is not good weather for the wireless, since good weather for wireless is good weather for ducks, as the saying goes. But the slow, powerful oscillations from the machine will go through any wind and weather, and the stations need not be idle just because the sun is shining. This means an immense saving of time in that feature alone. Professor Pupin believes that within a year many high-frequency generators will be installed at the wireless stations on both sides of the Atlantic. He himself has ordered one for use in the laboratory at Columbia University. Besides the fact that with this new method wireless transmission can go on at all times of the day, regardless of the weather, the use of the powerful machines such as can now be manufactured for a station will mean a considerable extension of the practicable distance range of the stations. "It will surely increase the distance," said Professor Pupin. "How much I do not know. It may double it or even treble it. That is something we will have to find out."

Prof. Pupin is an old friend of Marconi, and knows his subject thoroughly. He prophesies radical changes in wireless practice through the successful development of the high-frequency alternators. This lends great interest to Mr. Alexanderson's article.—*General Electric Review*.



### DEVELOPMENTS IN BATTLESHIP DESIGN

The fact that there is no possibility of arresting the development in size of battleships is once more established by two British ships to be floated this month\*—the *Iron Duke*, to be launched on Saturday at Portsmouth Dockyard, and the *Marlborough*, to follow from Devonport Dockyard on the 24th inst. Both vessels mark a large step forward in every respect, and still greater is the advance decided upon in connection with the vessels which will be laid down in the slips vacated by these two. The development in

\* October, 1912.

size has been continuous, and has been rendered necessary in order that our ships shall excel, in each unit which constitutes fighting power, the vessels designed for other navies. It can be said with absolute confidence now, as for many years, that these ships will be superior to anything yet projected in other countries. Some statements have been made regarding the coming ships; but as it is not considered desirable in the interest of the Service that any accurate details should be published, we refrain from referring further to them than to say that such particulars as have been already published are incorrect.

Of the *Iron Duke* class there are four ships, the two in addition to those already named, being the *Delhi*, under construction at Vickers' works at Barrow-in-Furness, and the *Benbow*, in course of construction at Beardmore's works at Dalmuir. All four vessels have a length of 580 ft. and a beam of 90 ft., the displacement being 25,000 tons. Since the advent of the *Dreadnought*, in 1905—seven years ago—the length has been increased by 90 ft., and the beam by 8 ft., while the displacement tonnage had been augmented by 7000 tons. This growth has been gradual. The *Dreadnought*, of 490 ft. and 17,900 tons displacement, was succeeded by three ships of the *Belcherophon* class, of the same length and 18,600 tons. In the following year, 1907-1908, three ships of the *St. Vincent* class were laid down, and their length was 500 ft. and the tonnage 19,250. Then came the *Neptune*, with the *Colossus* and *Hercules*, 510 ft. in length and of practically 20,000 tons. In these ships a change was made in the arrangement of the guns. All of the ships so far had been fitted with ten 12-inch weapons, although developments had been made in the length, and therefore in the power. The five barbettes in each were located as in the *Dreadnought*—one in the centre line forward, one in each fore quarter on the side, and two in the centre line aft; but in the three ships of the *Neptune* class the two pairs of after guns were placed at different levels, so that all four could fire astern.

The *Orion*, which was laid down at Portsmouth in the autumn of 1909, marked a new departure in many respects. It was in this ship that the 13.5-inch gun was first fitted, and at the same time the disposition of the guns was altered. The barbettes were all arranged in the centre line—two forward, one amidships, and two aft. As in the *Neptune*, those aft were arranged at different levels, and this system was also adopted for the four guns forward, so that the guns in No. 2 barrette fired forward over those in No. 1, and those in No. 4 fired aft over those in No. 5. Thus four guns were available for ahead fire and four for astern fire, while all ten could be fired on either broadside, as against eight in the preceding ships. This modification involved a considerable increase in the length of the ship, which became 545 ft., while the beam was 88 ft. 6 in., and the displacement 22,500 tons. Of this class three other ships were ordered—the *Conqueror*, *Monarch*, and *Thunderer*. In the programme of 1910-11 there were again four battleships—the *King George V.*, the *Centurion*, the *Ajax*, and the *Audacious*. In their case, the arrangement of the 13.5-inch guns was as in the *Orion* class, but the length of the ship was increased to 550 ft., the beam to 89 ft., and the displacement to 23,000 tons. The programme of 1911-12 provided for four battleships—of the *Iron Duke* class—and, as already mentioned, these have a length of 580 ft., a beam of 90 ft., and a displacement of 25,000 tons. The primary armament is the same as in the *King George V.*—namely, ten 13.5-inch guns, and the emplacement of the guns in the ship again corresponds generally with that evolved for the *Orion*.

There has been a development, too, in connection with what have hitherto been termed torpedo-repelling guns. In the *Dreadnought* it was considered sufficient, in view of the then range of the torpedo, to fit only 3-inch guns, but in subsequent ships the 4-inch gun was adopted, owing to the improvements in the torpedo and an increase in its range. The number of these guns fitted has varied, and changes in position have been made in order to protect them more effectually. For the most part they were accommodated in the superstructural work of the ship, behind shields. In the *King George V.* class 6-inch\* guns were adopted, and the change now made in the case of the *Iron Duke* is the fitting of the 6-inch guns behind the broadside armor on each side of the ship. This, in some measure, is a reversion to former practice, where secondary armament was adopted. It remains to be seen, however, whether there will be any departure from the tactical standpoint that in fleet actions big guns alone should be used; that will probably depend on the range and other circumstances of the moment.

As regards armor protection, there has been steady advance, principally in the thickness of the broadside armor, and no doubt this advance will continue in the case of the new ships. At the same time, the height of broadside protected by armor has been increased since the time of the *Dreadnought*, all vessels since the *Orion* having the armor carried up to the upper deck instead of to the main deck, as in the earlier ships.

As to speed, this has remained constant for battleships at 21 knots, under increasingly severe trial conditions, which gave assurance that it will be easily maintained, if not exceeded, in service. Experience has not shown the need for any material difference in the arrangement of the turbines in the ships so far ordered. On each of the four shafts there is an ahead and an astern turbine. The high-pressure turbines for ahead and astern working are independent; the low-pressure ahead and astern turbines on two of the shafts are incorporated within the same casing, so that six turbine casings suffice. The revolutions throughout have been maintained at about 300 to 320 per minute, which have been found to give good results, in respect alike of weight of machinery and of propulsive efficiency. The power, however, has had to be increased in order that the speed may remain constant, notwithstanding increased displacement tonnage. Thus, in the *Dreadnought* the designed power was 23,000 horse-power; this has steadily increased to 29,000 horse-power in the case of the ships to be launched this month. Thus while the tonnage has increased by 40 per cent, the designed horse-power has only increased by 20 per cent. In other words, the ratio of power to tonnage in the *Dreadnought* was about 1.28 : 1, and in the ships to be launched this month 1.16 : 1. Experience has enabled weight to be reduced without diminishing the adequacy of steaming capacity, which is so essential with turbine-driven ships, because of the ability of the engines to take an overload under emergency.

In the *Iron Duke* there will be one mast and two funnels; the tripod system of mast will not be adopted, the mast will be stayed with wire rigging, as in the case of the *King George V.* Tanks to counteract rolling and the submarine telephone system will be fitted. As in the *King George V.*, the officers will be berthed aft and the men forward.—*Engineering*.

\* Later information indicates the secondary armament of the *King George V.* class to consist of 4-inch guns, protected.—The Editor.



## THE SANITARY ORGANIZATION OF THE ISTHMIAN CANAL AS IT BEARS UPON ANTI-MALARIAL WORK\*

By Colonel WILLIAM CRAWFORD GORGAS

Medical Corps United States Army; Member of The Isthmian Canal  
Commission

The anti-malarial work on the Isthmian canal cannot well be understood unless preceded by a brief description of our sanitary organization as it bears upon this work.

The bulk of the activities of the Department of Sanitation on the Isthmus has no bearing upon sanitation, and in cities and municipalities in the United States this work is usually cared for by some other branch of the Government than the Health Department. I refer to such work as religious instruction, care of the sick, care of the insane, of lepers, street cleaning, garbage collecting, etc., etc.

The Department of Sanitation of the Isthmus spent last year some two million dollars, about one and a half millions of which was spent on non-sanitary matters and only five hundred thousand on purely sanitation. In this paper, therefore, I will not go into the general work of the department or its organization, but only so far as it concerns our anti-malarial work.

The United States on the Isthmus of Panama owns a strip of land ten miles wide (of which the canal is the center). This strip extends about forty-five miles in length from north to south. The population to be protected against malaria consists of about fifty thousand laborers and their families, and is scattered all over this five hundred square miles, though they are principally collected along the line of the canal, and more particularly into some forty camps and villages near this line.

The temperature, rainfall and character of terrain are all excellently suited for the breeding of anopheles all over this territory. The temperature is the same all year around, and high enough for mosquitoes to breed freely in every month in the year. The rainfall averages over a hundred inches yearly, and though there are four months in which there is practically no rainfall, there is enough water for the anopheles to breed freely during these four months.

The line of the canal passes through low and swampy ground for about one-third of its length, and through hilly ground the other two-thirds, but streams are so numerous in the high ground that anopheles breed about as well here as in the low ground.

During our five years of occupancy of the Isthmus we have brought in two hundred and fifty thousand people, and as these have been located principally in places formerly unoccupied along the line of the canal, and as the villages are intended for only temporary occupancy, the conditions are a good deal like those of an army going into a new country; and I think that our experience at Panama may be useful to us in our military occupation of tropical countries.

Our anti-malarial measures consist:

1. In destroying the habitat of the anopheles during the larval stage within a hundred yards of dwellings.

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\* Because of its applicability to a present problem of many artillery district commanders, the reproduction of this article from the *Military Surgeon* for April, 1909, has been suggested.

2. Destroying within the same area all protection for the adult mosquito.
3. Screening all habitations so that the mosquito cannot have access.
4. Where breeding places cannot be done away with by draining, use is made of crude oil, Phinotas oil and sulphate of copper for the destruction of larvæ.

I mention these measures in the order in which I consider them important. These measures are based upon the knowledge that the anopheles larvæ only live, as a rule, in clear, fresh water, in which there is a plentiful supply of grass and algae, and that the adult is weak on the wing, not generally flying far, and needs an abundant supply of grass and brush for protection against the breezes.

For the purpose of carrying into effect these measures, the five hundred square miles of territory have been divided into seventeen districts. These seventeen districts are under the charge of a chief sanitary inspector, who has in his office the necessary clerical force and three assistants. One of these assistants is especially competent in the life, history and habits of the mosquito; another in knowledge of ditching, tile draining, etc., and the other in knowledge of general executive work. Each of the seventeen districts has a district inspector in charge. Each district inspector has a sufficient force of laborers (forty to fifty) to do the necessary ditching and draining; a force of carpenters to keep the screening in repair, and one or two quinin dispensers, who are kept constantly going around giving three-grain doses of quinin to those who wish it. We do not attempt to force employes to take quinin prophylactically. The three assistants are kept constantly going over the work, advising and instructing the district inspectors.

The district physician sends in daily to the central office a report, showing the number of malarial cases occurring in his district and also the number of employes from which these malarial cases come. This report is consolidated weekly in the central office, showing the number of employes, the number of cases of malaria and per cent of malaria. A copy of this report is sent to each district inspector and he is held responsible for any excess of malaria in his district. If the admission rate for malaria during the week rises above one and one-half per cent something is considered wrong, and the assistants to the chief sanitary inspector are sent down to look over the ground and try to discover the cause.

The district inspector, for the purpose of doing away with the breeding places of larvæ, puts down tile drains wherever that would be suitable. This we consider the most effective and economical form of drainage. After it is once in, it requires no more attention. There is no breeding place left for mosquitoes, as no water whatever is exposed at the surface. A horse mower or scythe can be used for cutting the grass over it. Where tile drainage cannot be used we put down an open concreted ditch. The first cost of this is nearly as great as that of tile, and a certain amount of labor is necessary to keep it clear. It has to be swept out once a week to prevent obstructions, making little puddles of water in which the mosquito will breed. If the ground cannot be drained in either of the above ways, open ditches are used. This is the least effective and most expensive form of drainage. In Panama they rapidly fill up with grass and have to be cleaned out about once in two weeks. They are always breeding places for mosquitoes.

For the purpose of doing away with places which will harbor the adult mosquito, the inspector clears the ground of brush and grass for a hundred yards around the place to be protected. Where the locality is to be occupied

for a year or more, we have found it more economical to grade the ground and plant grass. The grass can then be kept down with a horse mower or scythe. We do not object to a limited amount of shrubbery or a few trees about a dwelling.

The inspector keeps the screens in repair by constantly going over them with his force of carpenters. The usefulness of screening depends entirely upon the care as to details with which it is put up. As put up by the ordinary carpenter, without expert supervision, it is of comparatively little use. Good wire should last, on the Isthmus, at least three years. There is plenty of screening on the market that will not last six months.

Prophylactic quinin is furnished in three grain doses either in solution in the form of a tonic, or in pills. It is placed on the table at all the messes, given to any employe who applies for it. Besides, we have from one to three dispensers in each district who go around to the various villages offering quinin to all employes who will take it. In this way we have about twenty thousand doses taken daily, when our rolls average forty-five thousand employes. We look upon prophylactic quinin as a most important measure.

The inspector uses crude petroleum, Phinotas oil and sulphate of copper in such places as cannot be drained. Oil is used in temporary pools caused by construction, or at temporary camps where it would not be economical to drain, and all places where for one reason or another drainage is not done. Phinotas oil is used for killing the larvæ in the algae and grass, as along the edge of a lake or swamp or the banks of a stream. Sulphate of copper is used for killing the algae in similar places. A very small amount accomplishes this result to a remarkable degree.

Under the above plan malaria has been affected as shown by the following table:

Year	Force	No. Cases Admitted to Hospital	No. Cases Per Thousand	Number Deaths	No. Deaths Per Thousand
*1904	6,747	422	125	9	2.66
1905	16,511	8,496	514	92	5.57
1906	26,705	21,938	821	199	7.45
1907	39,344	16,709	424	138	3.51
1908	43,890	12,372	282	59	1.34

For the past three years I do not think that for sanitary reasons we have objected to a force locating at any particular point. Usually when a new location is occupied the malaria rate is high, frequently as high as twenty-five per cent a week, but always in the course of a month or two, when the ground is drained and the brush cut, this drops to a rate somewhere in the neighborhood of one per cent.

I think that our methods could be applied to a considerable extent to military organizations. When troops are on the march in a malarious country the only practical protection would be prophylactic quinin. The only exposure to malarial infection would be in case they were billeted right in some town. With a fresh camp every night it is not probable that such anopheles as bit them would be infected. Where troops remained at one camp for a week or longer it would be practicable to clear and drain the ground.

\* Commences with the month of July.



The most important practical point in this work is that the sanitary officer should do the work himself. The men doing the ditching, brush cutting, etc., should be immediately under his control and he should be held responsible for the proper performance of the work. My experience has impressed upon me the fact that usually the officer in charge of this work has no special knowledge of mosquito life and habits and does not give due weight to details resulting therefrom. In general the laity are inclined to look upon the minutia of such work as trivial, and more or less ridicule is cast upon them.

As education extends it is possible that such work may be turned over to the engineer, or the quartermaster, or the provost of the camp, but at present I would always make it *sine qua non* that the sanitary officer be held responsible for the proper execution of the mosquito work in all its details, and, in order to enable him to properly carry out these details, he should have immediate control of the working force. My considerable experience has taught me that unless this is done the work is foredoomed to failure. I would like to make this point the gist of this paper—namely, that the sanitary officer should do the mosquito work himself, and not merely advise some other officer as to how it should be done. If I can impress the vital importance of this measure upon all sanitary officers hearing me I will feel that I have accomplished a great deal.—*Military Surgeon.*



### SEA STRENGTH OF THE GREAT NAVIES

Of the many published estimates of the relative sea strength of the leading navies of the world, probably none is so accurate as that which is issued annually by the Office of Naval Intelligence of the Navy Department. The Navy, through its naval *attachés* and its naval officers scattered throughout the world, has unusual facilities for gathering information of this kind, and the latest knowledge of this nature, published under date of December 1st, 1912, possesses unusual interest at a time when naval construction throughout the world has assumed such enormous proportions.

Unless the prognostications of naval strategy and tactics have been wrongly made, the fortunes of war in future naval campaigns will be decided chiefly by that modern type of fighting ship known as the dreadnought. Other things being equal, the nation which can put the largest number of these ships into the fighting line will have the command of the sea and the prizes of victory secure within her grasp. Let us, then, give first attention to the question of the relative strength of the leading navies in ships of the dreadnought type. We include both the battleships and the large and fast armored cruisers; and since ships are built and commissioned very rapidly in these days, we will base our comparison upon the combined totals of dreadnoughts, built, building or authorized. We find that England heads the list with 36 such ships, Germany being a strong second with 23, followed by the United States with 13; Russia, 11; Italy, 8; France, 7; Japan, 7; and Austria, 4. The significant fact for us in this comparison is that Germany, than whom we were stronger a few years ago, will within the next few years have 23 dreadnoughts against our 13.   \*   \*   \*   We should build three at the very least next year, in order to keep up with our yearly programme.

In battleships of the pre-dreadnought class with mixed armament, the

order is England, 40; United States, 25; Germany, 20; France, 20; Japan, 13; Russia, 8; Italy, 8; Austria, 6. In the destroyer class the order of strength is, England, 184; Germany, 131; Russia, 107; France, 84; United States, 56; Italy, 35; and Austria, 18. Of submarines England has 86, built, building or authorized; France, 89; United States, 47; Russia, 39; Germany, 32; Italy, 20; Japan, 16; and Austria, 13.

When all the vessels now building are completed the relative order of tonnage will be Great Britain, 2,478,152 tons; Germany, 1,124,267 tons; United States, 898,435 tons; France, 806,729 tons; Japan, 613,724 tons; Russia, 459,207 tons; Italy, 416,310 tons; Austria, 269,761 tons. Here we see that not only has Germany secured a long lead over the United States, but that France will soon be contending with this country for third place.

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—*Scientific American*.



## AERONAUTICS

It requires no great degree of intelligence to appreciate the fact that the past twelve months have witnessed a very large and striking advance in the field of artificial flight. The general public will no doubt always regard 1909 as the birth year of really practical flying. This statement is probably on the whole correct, for it was by such events as Blériot's cross-Channel flight and the first Rheims meeting that the public was taught to recognize the possibilities of the flying machine. The aeronautical history of 1912 has perhaps failed to produce a corresponding effect. Nevertheless to those who have followed it at all closely it chronicles as much progress as, and probably more than, any of its forerunners.

From the wealth of detail revealed by a glance back over the events of the year it is extremely difficult to select a representative summary, to discriminate between what is to be regarded as true progress and what as but of passing interest, and to single out those features which seem to indicate the general lines along which the science and art of flight is likely to develop during the next few years. There are many signs, however, that during the past twelve months the foundations have been laid for a new era in mechanical flight. The old order of affairs under which a few daring people were willing to risk their lives on imperfectly constructed machines for the sake either of the novelty of the thing or of prize money has very largely departed. On all hands aeronautics is being taken up in a much more serious spirit, and this is naturally having an important effect on the design and construction of the machines and on our knowledge of the conditions under which they perform their work. So far the military and naval use of aeroplanes is easily the most powerful force at work urging on their evolution. The qualities demanded of the military and naval machine are not, however, essentially different from those desirable in other types, so that no harm will be done if for the next few years the purposes of war are made the chief, or even the sole, motive for our efforts at improvement. We do not suggest that other fields should be neglected. There are many directions in which aeroplanes could be usefully employed for perfectly peaceful and useful objects. The carriage of passengers is the first and most obvious of these, and it is interesting to note that this application of the flying machine is apparently at



last within measurable distance of being successfully realized in the shape of the 200 horse-power seven-seated machine recently turned out by the Voisin Company. Then, again, for the carriage of mails and similar goods the aeroplane would appear to be gradually drawing nearer to a commercially practicable appliance. An ingenious arrangement has been developed whereby packages may be picked up from the ground by an aeroplane in full flight. This invention may not be of much consequence at the present moment. Still, it is by the accumulation of such details of operation that the employment of the aeroplane as a goods carrier will be made a financial proposition. Above and beyond the carriage of passengers and goods the development of the aeroplane for peaceful purposes is hardly likely to go in the immediate future. But when once a satisfactory stage of evolution has been reached in these matters many new and specialized uses will no doubt be discovered for it. Who will say, for instance, that the aeroplane, or hydro-aeroplane, will not one day form an important part of the equipment of the rescue stations around our coasts?

#### IMPROVEMENT OF DETAILS

With the establishment of the aeroplane industry on a large commercial scale a period of much activity in the improvement of details has set in. Many attempts have, for instance, been made to evolve an improved type of rotary motor. In spite of all that this class of prime mover has effected in the past, it is in its present form not regarded as the final word in aeronautical engines. Its efficiency is by no means as good as it might be, it is extremely wasteful of lubricating oil, and it is subjected to certain undesirable stresses when in action. In support of these contentions we may note that the official figures for the Army Aeroplane Competitions show that the average consumption of petrol by the machines fitted with rotary motors was 0.085 gallon per horse-power hour and that the average consumption of lubricating oil for the same machines was 0.02 gallon per horse-power hour. Of the non-rotary engines entered for the same competition we find one using 0.075 and another 0.066 gallon of petrol per horse-power hour, the respective oil consumption being 0.0034 and 0.0143 gallon. There is, therefore, clearly considerable room for improving the performance of the rotary type. The fact that the driving stresses of the rotary motor are transmitted through the pistons and cylinder walls is another point which has been subjected to criticism, and a rotary motor has been designed and constructed in which it is claimed the stresses are not thus transmitted. The gyroscopic forces called into play when a machine fitted with a rotary motor executes a sharp turn still possess a good deal of terror for some people, and various proposals, such as two contrary-running motors in the same plane or on the same axis have been made for their elimination. Direct experiment on the values of the gyroscopic couple arising from a Gnome engine has been made by the makers, Messrs. Seguin, and from the results it is clear that under all practical conditions the gyroscopic torque is considerably less than, say, those arising from a gust of wind such as occur and are checked repeatedly in every flight of any duration. It may be added that no aviator has so far been able unmistakably to feel the existence of gyroscopic force from his motor.

The problem of securing either automatic or inherent stability in aeroplanes still awaits a satisfactory practical solution. At the present moment the aviator, like the cyclist, depends very largely upon instinct for the preser-

vation of his balance. To convert the bicycle into a tricycle is the solution proposed by those who favor inherent stability, mostly, be it noted, the mathematical school headed by Professor Bryan. Those who regard automatic stability as preferable follow the lead of the Brennan mono-rail car, and seek to bring the stabilising means automatically into action only when the disturbing forces come into play. The commonest manner of effecting this is to employ some form of gyroscope, and it is quite surprising to notice how closely would-be inventors have, during the past year, been treading upon one another's heels in this matter. It is interesting to note that the scheme proposed by Mr. Lanchester, namely, the utilization of the gyroscopic effect of the rotary motor itself for securing automatic stability, was suggested by us in this article last year as a possible solution. The gyroscope is, however, not the only means available for the purpose, as witness the oil pump and inertia weight device to which M. Esnault Pelterie and others have been giving their attention. The use of a pendulum for the same purpose has also frequently been discussed. One of the latest ideas in this respect is to mount the motor on a swinging cross-member so that it itself may be utilized as a pendulum.

The progress made in the matter of materials of construction has been satisfactory. The tendency to rely less and less on wood and more and more on steel is more marked than ever. Thus at the Paris Aero Salon, which opened in October, out of 45 representative machines exhibited the framework of 10 was composed entirely of steel, 21 of wood and steel, and 14 of wood. At the present moment, then, the composite construction is most in favor. Last year wood was employed in by far the greater number of cases. But it can only be a question of time until this material is entirely eliminated and steel alone is used. A sign of the times in this matter was to be seen at the Paris Show in the shape of the Hanriot monoplane, the entire skeleton of which was composed of steel tubing welded together into one piece by the acetylene process. As regards propellers, it must be recorded that wood is still the favorite material to employ. Aluminium and steel have both been tried, but difficulty is experienced in uniting the blades to the boss in such a manner as will avoid centrifugal stress troubles. A recent proposal, however, involving the pressing of the blades and boss from a single piece of steel tubing seems to promise an improvement in this respect.

To turn to smaller matters, it is not without interest to note that several compositions or "dopes" for treating aeroplane fabrics have been placed on the market. The objects aimed at are the tightening and strengthening of the material and the rendering of it water and air-proof.

#### THE HYDRO-AEROPLANE AND THE AEROPLANE BOAT

Of all the developments which have occurred in the aeronautical world during the past year that of the hydro-aeroplane has been the most marked. Towards the end of 1911 this class of machine was very largely an untried appliance which had yet to prove its practical utility. Yet by the middle of 1912 it was being taken up by all countries interested in the marine side of mechanical flight, and by the end of the year we find it in as prominent a place in the aeronautical record as its brother of the land. We may take the opportunity here of suggesting that the very clumsy word "hydro-aeroplane" should be replaced by "hydro-vol." The etymology cannot be defended, but it is no worse than that of hydro-aeroplane. The Italian equivalent, it may be remarked, is *idro-volante*.

his orders and pressed forward on a new front. In the morning, however, he once more found his dispositions revealed to the defenders by their aeroplane scouts and the "battle" a foregone defeat.

At the present moment, according to Colonel Seely, the Royal Flying Corps has over a hundred members. The military wing is employing 14 biplanes, 16 more are on order, and tenders have been invited for a further 18.

#### DIRIGIBLE BALLOONS

The activity displayed during the past year in this branch of artificial flight has been by no means insignificant even when contrasted with the amount of work done in connection with aeroplanes. That anything like the same progress has been made is, however, an entirely different affair. It cannot be doubted that those who favor the dirigible balloon form still a very numerous class. France and Germany are, of course, the leading countries taken up with this type of machine, but whereas the former is pursuing an even more vigorous policy with regard to aeroplanes, the latter country, from the military point of view at least, is devoting almost its whole attention to dirigible balloons. At the end of the year Germany had 16 airships in commission and 9 under construction, and France 12 and 5 respectively. In this country the dirigible balloon has not done much during the past twelve months, and there was some reason for believing that the construction and destruction of the airship built at Barrow for the Navy had, after all, not been a complete waste of money. Mr. Churchill has, however, just destroyed our gathering hopes by announcing that the Admiralty has placed orders for two airships, one with the Aster Company, of Paris, and the other with the German Parseval Company. The latter, it is said, will have two motors of 150 horse-power each, and will have accommodation for a crew of twenty and fuel for twenty-four hours.

With regard to the actual work of dirigible balloons in 1912, we have again witnessed numerous flights of short or long duration ending in success or disaster, according as the weather and a hundred and one other chances were favorable or otherwise. There is no evidence whatever to show that these unwieldy aircraft are undergoing a process of evolution which will one day lead to the construction of anything more advanced than a fair-weather machine incapable of resisting the attack either of human enemies or of natural forces. At the French and British military maneuvers during the past year the dirigible balloons gave a very poor account of themselves. In Germany matters were apparently otherwise, but the secrecy of their doings is well preserved, and no trustworthy information can be gathered. Elsewhere the most notable event of the year in the airship world was the explosion on July 2nd of the dirigible balloon Akron at Atlantic City. This balloon represented Mr. Melvin Vaniman's second attempt to design an appliance which would carry him across the Atlantic. Both ended in disaster, and in the second the designer and his crew of four paid the penalty of their rashness with their lives. The airships Beta and Gamma, attached to the British Army, have been much in evidence during the year, but mostly by reason of their never-ending series of misfortunes. A small Willows airship designed to carry a pilot and a passenger has been acquired by the Navy, and, according to Mr. Churchill, has proved quite satisfactory "for the limited purposes for which it is intended." It is, however, said to be an extremely

frail contrivance. An airship of 350,000 cubic feet capacity for the Navy is currently reported to be under order from Messrs. Vickers.

—*The Engineer.*



### U. S. ARMY AEROPLANE SPECIFICATIONS

The Chief Signal Officer, U. S. Army, Brigadier General James Allen, has issued specifications for the two types of aeroplanes the Army has decided are most serviceable. These requirements follow:

#### A SPEED SCOUT MILITARY AEROPLANE

(1). Carry one person with the seat located to permit of the largest possible field of observation; (2). Ascend at the rate of 1500 feet in three minutes while carrying fuel for one hour's flight; (3). Carry fuel for a three hour's flight; (4). Must be easily transportable by road, rail, etc., and easily and rapidly assembled and adjusted; (5). The starting and landing devices must be part of the machine itself and it must be able to start without outside assistance; (6). The engine must be capable of throttling; (7). The engine will be subject to endurance test in the air of two hours' continuous flight; (8). Speed in the air of at least 65 miles an hour; (9). Capable of landing on and arising from plowed fields; (10). The supporting surfaces must be of sufficient size to insure safe gliding in case the engine stops; (11). The efficiency and reliability of the system of control must have been demonstrated before the purchase order is placed. The aeroplane must be capable of executing a figure eight within a rectangle 500 yards by 250 yards, and without decreasing its altitude more than 100 feet at the completion of the figure eight. This test to be made by aviator alone without carrying extra weight; (12). The extreme width of the aeroplane supporting surfaces must not exceed forty feet.

#### FOR SCOUT MILITARY AEROPLANE

(1). The aeroplane must carry two persons with seats located to permit of the largest possible field of observation for both; (2). The control must be capable of use by either operator from either seat; (3). The machine must be able to ascend at least 2000 feet in ten minutes while carrying a weight of 600 pounds, including the aviator and passenger, 150 pounds of gasoline and extra weight to make 600 pounds. All of the extra weight must be carried on the engine section and not distributed over the wings; (4). The fuel and oil capacity must be sufficient for at least four hours of continuous flight. This will be determined by a trial flight of at least one half hour, measuring the consumption of gasoline, while carrying the passenger and weight stated in paragraph 3; (5). Same as No. 4, above; (6). Same as No. 5, above; (7). The engine must be of American manufacture and capable of throttling to run at reduced speed; (8). Same as No. 7, above. This test will be made with aviator and passenger, extra weight and fuel enumerated in paragraphs 3 and 4; (9). The aeroplane must develop a speed in the air of at least forty miles an hour. This test will be made with aviator and passenger, extra weight and fuel enumerated in paragraphs 3 and 4. The maximum speed must not exceed 65 miles an hour; (10).

Same as No. 9, above. This test will be made with aviator, passenger, extra weight and fuel enumerated in paragraphs 3 and 4; (11). Same as No. 10, above; (12). Same as No. 11, above; (13). Same as No. 12, above.

—Aeronautics.



## ORDNANCE DEPARTMENT ACTIVITY

(Extracts)

For the months of September and October the following ordnance work is reported:

### THE ORDNANCE BOARD

*Test to determine the increase in range to be expected from the use of 700-pound projectiles in 12-inch mortars, model of 1886-90 MI.*—With a muzzle velocity of about 1200 feet per second the 700-pound long-pointed projectile gives an increase in range of about 1700 yards at 65 degrees and about 2300 yards at 45 degrees elevation over the 824-pound capped projectile with 1050 feet per second muzzle velocity.

*Test to determine if long pointed projectiles have a gyratory motion at long ranges and corresponding inaccuracy of flight.*—Nothing in the firings with long-pointed projectiles to indicate a greater unsteadiness of flight than with those having blunt points.

### FRANKFORD ARSENAL

*Drill cartridges.*—An order has been received to manufacture sufficient drill cartridges for 3-inch 15-pounder guns to provide one additional drill cartridge per gun for all guns in service.

*Dust and moisture proofing of instruments.*—Revised drawings of the 2-inch telescopic sight, observation telescope, seacoast and field, and B. C. telescope to make the instruments more nearly dust and moisture proof have been submitted to the Chief of Ordnance for approval. These changes have been approved for 2-inch telescopic sight and observation telescope, field. A B.C. telescope modified in accordance with these drawings has been forwarded to the Chief of Ordnance for examination.

### SANDY HOOK PROVING GROUND

*Test of Hadfield 14-inch A. P. shot, model of 1912.*—One projectile, s and loaded, was fired against a 12-inch Midvale Class A armor plate mounted and backed at 403 feet from muzzle of service 14-inch gun. Striking velocity, 1591 feet per second. Shot perforated plate and was recovered in condition for effective bursting.

### WATERTOWN ARSENAL

Thirty-two sets of parts for modification of 5-inch barbette carriage, model of 1896 traversing mechanism. Manufactured.

Four 12-inch mortar carriages, model of 1896 MIII. Manufactured.

Two 14-inch disappearing carriages, model of 1907 MI. Manufactured.

### WATERVLIET ARSENAL

Manufacture of thirty sets of adapters, chests and contents for 1-pounder sub-caliber guns for 6-inch guns, models of 1897 and 1908, 1900 and 1903.

Manufacture of sixteen 12-inch mortars, model of 1912.  
Manufacture of fifty-seven hand-loading trays for 4.72-inch, 5-inch and 6-inch guns.  
Manufacture of two 14-inch guns, model of 1910.—*Arms and The Man.*



## BI-MONTHLY ORDNANCE REPORT

*Special report of new work undertaken, of modifications in supplies for service, and of experiments and tests made by the Ordnance Department during the months of November and December, 1912.*

### ORDNANCE BOARD

*Test of type 14-inch gun and carriage, model of 1907.*—The test of the type 14-inch gun and carriage, model of 1907, has been completed. The tests included firing at 5 degrees depression, excessive pressure rounds at 15 degrees elevation, and a rapidity test. In the rapidity test the entire six rounds were fired in 3 minutes and 44 seconds under service conditions; the 3rd, 4th and 5th rounds being fired in 1 minute and 34 seconds.

The Board considers both gun and carriage satisfactory.

*Test of 3-inch telescope, model of 1912.*—The optical qualities of this instrument were found to be superior to those of the 3-inch telescopic sight, and the 3-inch telescope, model of 1904, and it is much better protected against injury by moisture and dust than any of the service models. The rubber hooded eye piece constitutes a decided improvement.

### FRANKFORD ARSENAL

*Drill projectiles.*—An experimental lot of one hundred 3-inch fixed drill projectiles have been manufactured and shipped to the service for test.

*Luting.*—Tests of a thin brass closing diaphragm soldered to the inside of cartridge cases have shown that it is more satisfactory than the usual luting for sealing purposes to protect the powder charge. It has therefore been adopted for all fixed ammunition.

*Sights.*—The manufacture of one hundred sights, model of 1912, for 2.95-inch Vickers-Maxim mountain gun carriage, has been undertaken.

*Battery commanders' telescopes.*—The modification of all battery commanders' telescopes, model of 1905, in store and in service to make these instruments more nearly dust and moisture proof has been undertaken.

*Fuze setters.*—Bracket fuze setters modified in accordance with the latest approved drawings to render them more nearly dust proof are now being issued to the service.

### ROCK ISLAND ARSENAL

*3-inch gun caisson.*—3-inch gun caisson has been outlined and the work on the general drawings is nearing completion. The brake on this vehicle will be operated by a hand wheel placed in a vertical position at 90 degrees to the plane of the wheels on the rear of the chest. The motion will be carried by two bevel gears, a vertical shaft and worm gear, and the usual cranks and spring rods to the brake arms.

*Schaller forge.*—A design has been established to operate the forge by means of a chain drive instead of a leather belt.



*German sled target.*—Four sled targets similar to the German design have been manufactured and will be issued for experimental purposes.

*56-inch wheel.*—An experimental hub cap plunger spring has been manufactured for this wheel. A dust guard has been designed which will be applicable to all 56-inch wheels and axles.

*4.7-inch and 6-inch howitzer carriages.*—Spare breech mechanism chest for 4.7-inch howitzer carriage has been manufactured. The panoramic sight case and bracket for the 3.8-inch howitzer carriage can be used on both the 4.7-inch and the 6-inch howitzer carriages. Bucket holders have been adopted for all 4.7-inch gun and 6-inch howitzer limbers.

*Portable forge.*—The soft rawhide bellows of the forge have been replaced by bag leather which is more durable, as the rawhide dries out and cracks.

*New riding saddle.*—The work of designing a suitable mule riding saddle has been undertaken.

*Aluminum canteens.*—Ten welded aluminum canteens have been manufactured for test in the field.

*Carrying case for battery commanders' telescope.*—In order to reduce the weight an experimental case made of one thickness of leather with a metal reinforce perforated has been manufactured. This change reduces the weight of the case from 11 ½ pounds to 7 ½ pounds.

*Dispatch case.*—A case has been manufactured with a flap on the top made of one piece of leather in order to keep out water. The pencil pockets are on the inside with a slit through the case so that the pencils can be inserted from the outside.

#### WATERTOWN ARSENAL

*Modification of 15-pounder barbette carriages.*—Forty sets of parts for modification of 15-pounder barbette carriages, model of 1898 to model of 1898 MI. Manufactured.

*Automatic clutch for 10-inch disappearing carriage.*—One set of parts for automatic clutch arrangement 10-inch disappearing carriage, model of 1894 MI, in order to obviate possibility of an accident occurring from retracting crank striking man operating retracting controller. Manufactured.

#### WATERVLIET ARSENAL

*Gas-check pad containers.*—Purchase of six hundred and twenty-two gas check pad containers. To remedy the difficulties encountered due to expansion of gas check pads in store by absorption of moisture. 12 sizes of pad containers will be provided for the twenty-one sizes of pads in service. They will be made of No. 13 zinc gauge and sealed with a soldered strip.

*4.7-inch howitzers, model 1908.*—Manufacture of twenty-eight 4.7-inch howitzers, model of 1908, complete, with spare parts.

*4.7-inch howitzers, model 1912.*—Manufacture of sixteen 4.7-inch howitzers, model of 1912, complete with spare parts.

*Navy guns.*—Manufacture of five 14-inch Navy guns.



#### THE CASE OF THE R.G.A. (COAST DEFENSE) SIGNALLER

(Because of its general application, the following extract is taken from an article of the same caption by "Signaller," in the *Journal of the Royal Artillery* for December, 1912.)

These duties of the coast defense signaller will be as follows:—

(1). Working *short* messages through the different branches of the artillery chain of command by telephone, or in case of a breakdown of the telephone system (a most likely occurrence), by flag, helio, or lamp, *at a very rapid rate*.

(2). Communicating with H.M. ships by means of mechanical semaphore, morse flag, helio, lamp or code flags. The messages in this case may be somewhat longer than in (1), *but the rate of working required will be very rapid*.

(3). Observation of fire, and signalling in of results, from the flanks of a battery, *at a very rapid rate*.

It may be asked why this last duty is included?

The answer is, that flank observation will, in actual warfare, be an absolute necessity, to enable a B.C. to correct the fire of his guns, when engaging a target at long ranges, and there is no doubt that flank observers should be much more used at practice than they are at present.

Observations from a flank, however, are useless to the B. C. unless he has absolute confidence in the observers, and unless the results are very quickly sent in to him. These conditions make it necessary for the observers to be very highly trained, and signallers are undoubtedly the best for the purpose.—*The Journal of the Royal Artillery*.

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## Short Notes

*First Fighting Line Monsters*.—As we have before pointed out, the difference between the battleships which are being built as part of this year's programme, and those of the "*Dreadnought*" group which have gone before, is quite as distinctive as the difference between the name ship of modern fighting leviathans and her predecessors now known as pre-"*Dreadnoughts*." Some distinctive features are already showing themselves in the "*Iron Duke*" group, which are entering the completing stage, but these are only the shadows of coming events. In the ships now in their earliest stages of construction, and which will follow the "*Iron Dukes*" into the first fighting line, there will appear the single mast to carry the wireless installation, turtle-back upper deck composed of stout armor plates, and armored hoods over the funnels of the vessels, which are so fitted to meet the overhead bombdropping attack of aircraft. The control of gunfire will likewise be exercised by officers housed in armored towers, so placed as to secure an all-round, uninterrupted view of the horizon, so far as this can be accomplished; while the wireless operator and instruments will also be placed behind armor plates. The increased size and lesser number of heavy guns—eight weapons of 15-inch calibre—backed by a powerful secondary battery of 6-inch guns, such as we have always argued for in these columns, will put the displacement up to about 27,000 tons, and so place many eggs in one basket; but it must be admitted that such vessels will give us a new lead in naval construction and push us still further ahead of our rivals in all that goes to produce an invincible fleet in the first fighting line.—*United Service Gazette*.

*Two New British Battleships*.—The new British battleships just laid down under the 1912-13 naval programme will not be launched until June



next. It is understood that these ships will not be much larger than the *Iron Duke* and *Marlborough*. In addition to the ten 14-inch guns (compared with the 13.5-inch of the earlier vessels), a much higher speed, and better armor protection, the two new ships will carry a number of anti-air-craft guns, probably 4-inch. The mountings will enable these guns to be elevated to 80 degrees, and a 31-pound shell will be used, with a charge sufficient to send a projectile to a height of 27,000 feet. The shell will be shrapnel, with a time fuse, and a bursting charge to scatter the fragments and bullets over a wide area.—From *Shipping in United States Naval Institute Proceedings*.

*Two More British Battleships.*—The vessels are to be similar to the two which were recently laid down at Portsmouth, and Devonport respectively. They will be, that is to say, of about 27,000 tons displacement, and turbines of between 50,000 and 60,000 h.p. will give them a speed of about 25 knots. Their armament will consist of eight 15-inch guns arranged in pairs on the middle line of the ship and 16 6-inch guns.—*Pages Weekly*.

*The New British Battleships.*—The four new battleships of 27,000 tons and eight 15-inch guns, will, it has been definitely decided, be given the following names: *Queen Elizabeth*, laid down at Portsmouth on October 21st; *Warspite*, laid down at Devonport on October 31st; *Valiant* and *Barham*, to be built in private yards. This is the first occasion since the advent of the *Dreadnought*, on which Great Britain has begun work before the close of the year on four ships of the same type. Here are additional details of the ships: besides the eight 15-inch guns, they will carry sixteen 6-inch, 50-caliber guns of a new model, an as yet undetermined number of 4-inch guns, and five 21-inch torpedo tubes, one stern and two on each broadside; the length of the ships will be 672 feet; machinery, 56,000 horse-power, Parsons turbines, Babcock or Yarrow boilers, oil fuel; and a special protective deck against attack from aeroplanes.—*Le Yacht*.

*The Pennsylvania.*—Plans for the battleship *Pennsylvania* have been completed and bids for its construction will be opened on Feb. 18, according to recent press dispatches from Washington, D. C.

The dimensions of the new dreadnought are: Waterline length, 600 ft., overall length, 608 ft.; beam 97 ft. 0½ inches; draft, 28 ft. 10 inches; displacement, 31,400 tons. The boat is designed for a speed of 21 knots an hour and her armament is to consist of twelve 14-inch guns and four submerged torpedo tubes with a torpedo defense battery of twenty-two 5-inch guns. Her water line armor plate is to be 16 inches thick.

Oil-burning boilers of the water-tube type will furnish steam to the driving engines. It is reported that the decision as to whether turbines or reciprocating engines are to be used for propelling the big boat, has been reserved until the bids have been examined.—*Engineering News*.

*A New German Battle Cruiser.*—The German battle cruiser *Ersatz Kaiserin Auguste* was laid down at the Schichau yard, Dantzig, on Sept. 5, and already it is announced that from 4000 to 5000 tons of material are in place. She is the first of the German battle cruisers to be built in any other yard than that of Messrs. Blohm and Voss, at Hamburg. The vessel is regarded as a reply to the British *Lion* and *Princess Royal*, and is stated to be the prototype of a new class, armed with 15-inch guns. Upon the latter

figure, says *The Navy*, a great deal of doubt may be thrown, for there is no reason to suppose that the Germans have yet advanced much beyond the 12-inch gun, which is to be mounted in the *Seydlitz*. This is the vessel which was launched in March by Messrs. Blohm and Voss.

—*Army and Navy Journal*.

*New French Ships*.—The Minister of Marine has decided to lay down four battleships of the *Dreadnought* type during the coming year instead of the two as originally proposed.

A commencement has been made at the Lanester Yard at Lorient with the *Provence*, one of the three super-dreadnoughts of this year's programme; she is being built on the same slip on which the *Mirabeau*, of 17,000 tons, now one of the ships of the First Squadron, was constructed, and also the *Courbet* of 23,000 tons, now completing. The *Provence*, and her two sister-ships, the *Bretagne* and *Lorraine*, are an improvement on the four ships of the *Jean Bart* class; instead of twelve 12-inch guns, which those ships are to carry, the new vessels will be armed with ten 13.4-inch guns, which will be mounted in five double turrets on the centre line, the turrets immediately abaft and before the fore and after ones respectively being raised to fire over them. It is reported that their dimensions will now be as follows:—Length, 541 feet; beam, 88.56 feet, with a displacement of 23,500 tons. The secondary armament will consist of 24 six-inch guns, with four torpedo tubes. The engines are to develop 28,000 I.H.P., giving a speed of 20 knots.

—*Journal of the Royal United Service Institution*.

*A New Japanese Cruiser*.—The Japanese cruiser *Hiyei* has just been launched at Yokosuka. The *Hiyei* is one of four armored cruisers with a displacement of 27,500 tons each, now in course of construction for the Japanese Government. She is similar to the *Kongo*, now in course of construction at Barrow by Vickers, Limited. She will carry twenty-four guns and five submarine torpedo-tubes. She is to be fitted with Parsons turbine engines working up to 64,000 horse-power.—*Engineering*.

*Director Firing*.—It seems probable that the result of the firing tests which were concluded off Berehaven last week between the *Orion* and the *Thunderer* may bring about an important change in the gunnery system of our own and foreign fleets. The conditions and circumstances of the tests were specially arranged so that the new director might have a fair and exhaustive trial, and the verdict has clearly established its superiority. The manner in which the projectiles from the directed guns of the *Thunderer* fell upon the target appears to have been considered little short of marvellous by those who saw it, and the opinion was naturally expressed that no ship, however well protected, could have stood up for many minutes against such fire. Of course, there was no return fire for the *Thunderer* to contend with, an element of unreality inseparable from any peace experiment of the kind, but the result of last week's tests would seem to justify the authorities in increasing the range for practice in future. In fact, as we believe was said several years ago by an experienced gunnery officer, the ship which can first get the range of another and plant her shells upon the hull of her enemy, should, everything else being equal, come off the victor. The exact details of Sir Percy Scott's invention are naturally kept secret, but seemingly it resembles in effect the "director" which Captain Moorsom introduced about

1850, and which in various forms was in use in the Navy until ships ceased to carry broadsides of numerous guns of the same calibre. When only two heavy gun turrets became the rule the director was discarded, but it has been a matter of some comment that with the advent of the "Dreadnoughts" it has not been revived in some way or other. Apparently something of this kind has now taken place, though the contrast between the Moorsom instrument and the new one, in which advantage has been taken of the great and numerous scientific improvements of the age, could not fail to be most marked. The *Thunderer's* achievement is a great victory for Sir Percy Scott, whom we heartily congratulate upon the complete success which, after many delays which occurred through no fault of his own, has now crowned his latest efforts to improve the marksmanship of the Navy.

—*The Army and Navy Gazette.*

*Director Firing.*—The result of the comparative tests which have been held between the battleships *Thunderer* and *Orion* establishes definitely the superiority of Sir Percy Scott's system of director firing over that hitherto in use. For four years it has been questioned whether the new method was superior to the old, and it was to settle the matter conclusively that the Admiralty ordered the experiments to take place between the *Thunderer*, which was fitted with the new invention, and the *Orion*, which was not. The two vessels were to fire at the same time with the same range and targets, and in order to make the trial as effective as possible, it was held in the Atlantic in rough weather, not necessarily in a storm, but with the ships rolling at least five degrees each way. Under these conditions the *Thunderer* made five times as many hits as the *Orion*, and completely eclipsed all previous records of firing, including those obtained in fine weather. It is said that the broadsides of the *Thunderer*, sometimes from five and sometimes from 10 guns, seemed to rain on the target. The new system, it is understood, will be fitted to all armored ships with the least possible delay. After the firing the *Thunderer* left for Portland, where she has since arrived.

—*United Service Gazette.*

*Director Firing.*—The *Thunderer*, using Admiral Sir Percy Scott's newest gunnery invention, the Fire Director, has once more beaten all records in naval gunnery. Ships of the Second Squadron returned to Portland on Saturday after five days' firing tests off Weymouth. The *Telegraphs'* correspondent learns on good authority that the *Thunderer* eclipsed everything previously done. The best day was Wednesday, when, in the presence of the umpire's ship, the *Thunderer* opened fire at 10,000 yards range on a target of the latest pattern. The first firing was in groups of five guns, four rounds of 13.5 ammunition being got off with excellent results. Afterwards the whole broadside of ten guns was fired three times at the target, which at the conclusion of the firing was a total wreck, scarcely visible at one mile distance. An examination of the target made by the umpires showed that of the fifty rounds fired no fewer than forty-one were direct hits—an extraordinary achievement, completely eclipsing anything hitherto known. The previous best was the *Thunderer's* thirty-seven out of fifty, made off Berehaven recently, and that beat the *Orion's* previous record of twenty-four out of thirty, at 6500 yds., made before King George off Portland Bill last May.

—*Page's Weekly.*

*Insensitiveness of Cordite.*—The deplorable ignition of cordite at the works of Messrs. Nobel's Explosives Company supplies another proof of the safety of this material. Not by the evidence of one such accident but unluckily of several it has been demonstrated that inflammation never develops explosion, even when many tons in close magazine confinement are involved. The one solitary exception was the experimental ignition at Woolwich, but though the circumstances were never fully disclosed, it is considered that the fact of the material being small arms rifle cordite, leaves untouched the clean bill of health of the larger artillery sizes. The subject is one of peculiar interest to the trade at a time when all the resources of manufacture are being strained to the utmost. If cordite is not an explosive under storage conditions, a very large relaxation of the present magazine restrictions would appear to be justified. That all such aid as can justly and with due regard to public safety be vouchsafed is most necessary, is probably as well known to the Home Office authorities as it is unpleasantly obvious to the trade. However ample the area upon which a factory stands, the arrangements of its space is usually dominated by outside influences, and these are the more difficult to meet when large magazine accommodation has to be associated with a generous scheme of isolation. Circumstances alter cases, and the so fully proved insensitiveness of cordite under great provocation is a new fact having a significance that ought not to be ignored.—*Arms and Explosives.*

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## NOTICES

### MILITARY INVENTIONS

#### RECENT U. S. PATENTS OF MILITARY INTEREST

A complete copy of any patent here listed may be obtained of H. B. Willson & Co., Patent Attorneys, 715 Eighth St., N. W., Washington, D. C. Enquirers should indicate patent number and remit ten cents.

#### AERONAUTICS

- 1,045,388 Propelling and Lifting Device for Aeroplanes, Phineas Gilbert, Spokane, Washington.
- 1,045,657 Safety Balanced Air Machine, G. M. Absalom, Caiston Centre, Ontario, Canada.
- 1,044,914 Landing and Launching Platform for Aeroplanes, Byron C. Riblet, Spokane, Washington.
- 1,045,030 Elevator for Aerial Vessels, Alex. Horton, Portsmouth, Eng.
- 1,046,023 Airship Life Saver, Francois Rilleau, Los Angeles, Cal.
- 1,047,266 Turbine-Driven Helicopter, Gustav Mees, Charlottenburg, Ger.
- 1,047,759 Means for Maintaining the Lateral Equilibrium of Aeroplanes, T. B. DaPaz and A. M. C. DeFaria E Maya, Miguel, Azores.
- 1,047,827 Electrically Operated Balancing Mechanism for Aeroplanes, R. L. Monroe, Sioux City, Iowa, Assignor to J. W. Monroe.

## ARTILLERY

- 1,045,720 Limber-Coupling for Artillery-Vehicles, Wilhelm Mayer, Essen-on-the-Ruhr, Germany, Assignor to Fried. Krupp, Aktiengesellschaft, Essen-on-the-Ruhr, Germany.

## AUTOMOBILES

- 1,044,919 Sanding Device for Automobiles, Lester W. Samuels, New York.

## PROJECTILES, ETC.

- 1,045,075 Projectile and Method of Firing the Same, Riccards Pompile, Villins Arnaldi, Tivoli, Italy.  
 1,047,773 Lifting and Transporting Apparatus for Projectiles, John A. Essberger, Berlin, Germany.  
 1,045,804 Grab for Lifting Projectiles, R. H. S. Bacon and Frank W. H. Shepherd, Coventry, England.

## SHIPS (NAVAL), ARMOR, ETC.

- 1,045,691 Manufacture of Armor-Plating, Ernst Fischer, Dietrichsdorf, near Kill, Germany.

## SIGHTS, ETC.

- 1,048,975 Method of Adjusting the Sights of Guns, William Konig, Brunswick, Germany.

## SMALL ARMS, TARGETS, ETC.

- 1,045,373 High-Power Air-Rifle, E. P. Cook, Granville, Ohio.  
 1,044,983 Box-Magazine for Firearms, Milton W. H. Brown, Trenton, N. J.  
 1,047,690 Adjustable Stock for Firearms, O. E. Oliver, Mount Eden, Cal.  
 1,045,713 Pistol-Holster Hanger, F. B. Lewis, Capitola, Cal.  
 1,047,671 Recoil Loading Pistol with fixed Barrel, Paul Mauser, Oberndorf-on-the-Neckar, Germany.

## SUBMARINE MINES AND TORPEDOES

- 1,044,543 Stopping Device for Automobile Torpedoes, Frank M. Leavitt, Smithtown, N. Y., Assignor to E. W. Bliss Co., Brooklyn, N. Y.  
 1,046,192 Means for Launching Torpedoes from the Sides of Ships, Albert E. Jones, Fiume, Austria-Hungary, Assignor to Whitehead & Co., Fiume, Austria-Hungary.

## MISCELLANEOUS

- 1,045,719 Tilting Ammunition-Wagon, Wilhelm Mayer, Essen-on-the-Ruhr, Germany, Assignor to Fried. Krupp, Aktiengesellschaft, Essen-on-the-Ruhr, Germany.  
 1,045,761 Ammunition-Wagon, Karl Voller Dusseldorf, Germany, Assignor to Rheinische, Metallwaren-und Maschienenfabrik Dusseldorf-Derendorf, Germany.



## BUREAU OF MINES' PUBLICATIONS FOR FREE DISTRIBUTION

We have been asked to print the following:

## DEPARTMENT OF THE INTERIOR

## BUREAU OF MINES

## New Publications

(List 15.—December, 1912.)

*Bulletins*

Bulletin 49. City smoke ordinances and smoke abatement, by S. B. Flagg.  
1912. 55 pp.

*Technical Papers*

Technical Paper 27. Monthly statement of coal-mine accidents in the United States, January to August, 1912, including statistics for 1910 and 1911, compiled by F. W. Horton.  
1912. 24 pp.

Technical Paper 29. Training with mine-rescue breathing apparatus, by J. W. Paul. 1912. 16 pp.

*Miners' Circulars*

Miners' Circular 9. Accidents from falls of roof and coal, by G. S. Rice.  
1912. 16 pp.

Miners' Circular 10. Mine fires and how to fight them, by J. W. Paul. 1912.  
14 pp.

The Bureau of Mines has copies of these publications for free distribution, but cannot give more than one copy of the same bulletin to one person. Requests for all papers can not be granted without satisfactory reason. In asking for publications please order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

## BOOK REVIEWS

**Histoire Elementaire de L'Architecture Militaire.** Volume I. By A. Mersier.  
Paris: Ernest Leroux, 28, Rue Bonaparte. 5" x 7½". 243 pp. 6 il.  
Paper. 1911.

This work reviews the history of fortification among such peoples as have made their influence felt in Europe, and especially in France. The first volume, here reviewed, stops at the end of classic antiquity. A second volume will pursue the subject to the end of the sixteenth century, which marks the transformation of military architecture under the final triumph of gun-powder ordnance.

Fortifications have at times been so preponderant in world politics that their history merits an extensive study.

After setting forth the various methods and subterfuges employed by the assailants to gain possession of the places of their enemies, our author shows in a delightfully interesting manner how the engineers of the defenders provided, at every turn, against the particular lines of activity to be feared. Surprise in time of peace, investment and blockade, escalade, the attacks of the miner, the sapper, and the battering ram, the hail of missiles destined to sweep the defenders from the ramparts, and even treason and treachery from within, where each and every one met by some defensive device. Fortification was, of course, but a reply to the means of attack employed.

Nor were works of fortification confined to the defenders. Owing to the protracted length of sieges, the danger of sorties from within and of relieving armies from without, the besieger was frequently forced to fortify to protect his camp against surprise and his engines of attack against destruction. Thus, before Alesia, Caesar surrounded the city with a line of contravallation and himself with a line of circumvallation of gigantic proportions. More than once the besieger was led to build a regular city before the one besieged.

It is said nowadays that no place can, of itself, stand before systematic attack. In ancient times, however, the chances were in favor of the defenders. History shows few cases of strongholds which fell before the methodical attacks of besiegers. Those which did, usually succumbed to surprise or treason.

All evidence points to the great Asiatic empires of Chaldea, Assyria, and Persia as the seat of the first great strides in the art of fortification. For although they seem to have lacked any form of artillery, their recovered bas-reliefs show scientific combinations, suspended battering rams, assaulting towers, and the operations of sappers and miners. Their only available material being clay, and commanding as they did the services of whole nations held in captivity, they built sun-dried brick walls of huge mass and great perimeter, enclosing areas capable of self-support from the produce of the soil. Their ramparts, crowned with commanding towers, were of multiple trace, the outer wall being commanded by an inner, which, in some cases, was commanded by a third.

The Egyptians appear to have added little or nothing to the art of fortification. After their great Asiatic campaigns, although their engineers



strove to imitate the works of the Asiatic orient, they never excelled nor even equalled them. In Egyptian works we find less ingenuity developed in protection against the enemy than against the ever present danger of the overflowing Nile.

The fortifications of the Greeks fall into three general periods: the Pelasgian period, before the age of iron, when, owing to the difficulty of stone dressing, large blocks of native rock were used, giving rise to the belief of Cyclopean origin; the Hellenic period, in which dressed stone and brick anchored by oak beams were used, and in which the arch was unknown and the power of the defense depended less upon the strength of the works than on the activity of the garrison; and the Greco-Oriental period in which, having lost their independence and come into contact with the master architects of Asia, the Greeks, under the Byzantine empire, became, in turn, the military engineers of their day.

In Italy we find Pelasgian fortifications, identical with those in Greece. The Etruscan structures of a later period show the use of iron implements, the knowledge of the arch and of flanking towers. The Etruscan influence only, was felt by the Romans up to the Punic wars, then conjointly with the Hellenic, which became preponderant under the Empire.

Ancient warfare was largely confined to the investment and defense of cities. Under the Republic the Roman legions operated in wild, uncivilized countries, and the art of fortification was specialized with a view to guarding their camps from surprise and breaking the rushes of the barbarian hordes in battle: whence the origin of the armed camp, which under the defensive attitude of the crumbling empire gave rise to the walled cities, and later to the feudal castles of the northern conquerors. The Romans sought naturally defensive frontiers; but, where the natural strength was wanting, they substituted long lines of frontier works, such as those in Britain.

The Gauls were a primitive, neolithic race. While ignorant of the arts of masonry and stone dressing, their natural ingenuity had led them to develop works of cribbed timber and packed stone, which resisted both fire and the ram, and, although devoid of scientific dispositions, held the legions of Caesar at bay and forced him to some of the most extensive siege operations known to history.

The subject as presented by M. Mersier is extremely fascinating, and a study of his work would be of great value to any one contemplating a visit to the cities and castles of the old world where the history of ages can be read in the stones.



**Bible Atlas.** By T. MacCoun. New York: L. L. Poates Publishing Company, 22 North William Street. 4¾" x 7". 122 pp. maps; 125 pp. text. Leather. 1912. Price: \$1.00; with text, \$1.50; postpaid.

Anything in the way of ready information which will increase our interest in the Bible is of value; and a compendium that enables us to understand the influences, geographical or moral, which produced that unsurpassed literary product of a nation is especially important. Such a compendium we have in the physical, geographical, and historical maps, accurately drawn, clearly colored, and accompanied by appropriate text, of MacCoun's Bible Atlas.



The information given us in this Atlas has been carefully selected, and is of especial value because it has been so scientifically arranged. Indeed, it must have required great labor on the part of the compiler to select the wheat from the chaff of the voluminous and controversial literature of the subject with which he is here concerned, and then to present it in such a readily assimilable form.

The book, which is of convenient size, contains thirty-eight beautifully tinted physical maps of Palestine on which every site of importance has been clearly marked after careful identification, and eighty-two progressive historical maps illustrative of the various periods of the countries' history from the earliest date to the present time.

The profile maps, based upon the results of an actual survey, are believed to be a new departure in biblical geography and are of great value.

The text, which constitutes about the latter half of the volume, treats the subject geographically, and in a series of one page studies tells of the volcanic formations, the size of Palestine, the Plains of Islam, the Galilees, the mountains, the post-diluvians, the selected family, the Holy Man, the Talmud, and other subjects of like interest.

The Atlas may be commended as an interesting and instructive compilation by a careful and accurate author.



**The Head Hunters of Northern Luzon. From Ifugao to Kalinga.** With an Appendix on the Independence of the Philippines. By Lieutenant-Colonel C. De W. Willcox, Prof., U. S. M. A. Kansas City, Mo.: Franklin-Hudson Publishing Company. 6" x 9". 304 pp. 63 il. 1 map. Cloth. 1912. Price, \$1.50.

In his book, "Head Hunters of Northern Luzon and Independence of the Philippines," Lieut.-Col. Willcox, in a most graphic style, shares with the reader his interesting experiences and instructive observations incident to a tour through the Mountain Province of Northern Luzon in 1910. The tour was made under most favorable circumstances for accurate observation, Lieut.-Col. Willcox, by special invitation, accompanying Mr. Worcester, Secretary of the Interior of the Philippine Islands, on his annual inspection of the province.

The book abounds in incident, is rich in information, and is written in a charming style. There are, indeed, chapters and illustrations that are gruesome—the chapters probably necessarily so, as an incident to the subject; but, withal, a delightful sense of humor pervades the book, and it is so graphic in presentation that the reader feels that he himself has made the tour.

In an appendix the author, taking as his text, "Am I my brother's keeper?", presents very forcefully his views on the subject of the independence of the Philippines. It is his opinion that the United States should continue to administer the affairs of the Philippine Islands; and the facts he presents and the arguments he adduces in support of that opinion are so illuminating and sound, as to render a consideration of them an incident to the discharge of the duty of American citizenship.

# KEY TO INDEX TO CURRENT MILITARY LITERATURE

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The periodicals cited are arranged by government, and each periodical is assigned a symbol consisting of an initial, or other abbreviation of the governmental designation, and a numeral indicative of the periodical's position in an alphabetical arrangement of the Journal of the United States Artillery's exchanges under that government.

Prices of subscription are given in the currencies of the countries of publication.

\* All the periodicals cited are preserved in the Library of the Coast Artillery School at Fort Monroe, Virginia.

## ARGENTINE

<i>Ar-1</i>	<i>Boletin del Centro Naval</i> Florida 659, Buenos Aires	Bi-monthly Per year \$ <sup>m</sup> /₮11.90
<i>Ar-1.5</i>	<i>Revista del Circulo Militar</i> 255 Maripu Buenos Aires	Monthly Per year \$12.00
<i>Ar-2</i>	<i>Revista Militar</i> Ministerio de Guerra, Santa Fe 1161 Buenos Aires	Monthly Per year \$ <sup>m</sup> /₮9.00

## AUSTRIA

<i>Au-1</i>	<i>Mitteilungen aus dem Gebiete des Seewesens</i> Pola	Monthly Per year 17 M
<i>Au-2</i>	<i>Mitteilungen ueber Gegenstaende des Artillerie-und Genie-Wesens</i> Getreidemarkt 9 Wien, VI.	Monthly Per year 20 M
<i>Au-3</i>	<i>Streffeurs Militaerische Zeitschrift zugleich Organ der militaerwissenschaftlichen Vereine</i> I. Graben, 13. Wien	Monthly Per year 28 M
<i>Au-4</i>	<i>Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines</i> I. Eschenbachgasse, No. 9 Wien	Weekly Per year 34 K

## BELGIUM

<i>Be-1</i>	<i>Belgique Militaire, La</i> Rue Albert de Latour 50 Schaerbeek, Brussels	Weekly Per year 12 fr 50
<i>Be-2</i>	<i>Revue de l'Armee Belge</i> 21 Rue des Guillemins, Liege	Bi-monthly Per year 13 fr
<i>Be-3</i>	<i>Revue de l'Ingenieur et Index Technique</i> 88, Rue de Ruysbroeck, Brussels	Monthly Per year 30 fr

## BRAZIL

<i>Br-1</i>	<i>Boletim Mensal do Estado Maior do Exercito</i> Ministerio de Guerra Rio de Janeiro	Monthly
<i>Br-2</i>	<i>O Tiro</i> Rio de Janeiro	Bi-monthly
<i>Br-3</i>	<i>Revista Maritima Brasileira</i> Rua D. Manoel n. 15 Rio de Janeiro	Monthly Per year 12\$000

## CHILE

<i>C-1</i>	<i>Memorial del Estado Mayor del Ejercito de Chile</i> Talleres del Estado Mayor-General Santiago	Monthly
<i>C-2</i>	<i>Revista de Marina</i> Casilla del Correo 976, Valparaiso	Monthly Per year \$15.00

## COLUMBIA

<i>Co-1</i>	<i>Memorial del Estado Mayor del Ejercito de Colombia</i> Jefe del Departamento de Historia del Estado Mayor-General Bogota	Bi-monthly Per year \$0 50 oro
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## DENMARK

<i>D-1</i>	<i>Militært Tidsskrift</i> Copenhagen	Semi-monthly Per year 8 kr
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## FRANCE

<i>F-1</i>	<i>Archives Militaires</i> Librairie Militaire Berger-Levrault 5-7 Rue des Beaux-Arts, Paris	Quarterly Per year 14 fr
<i>F-2</i>	<i>France Militaire, La</i> 10 Rue Danton, Paris	Daily Per year 32 fr
<i>F-3</i>	<i>Genie Civil, Le</i> 6 Rue de la Chaussée d'Antin, Paris	Weekly Per year 45 fr
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<i>F-12</i>	<i>Revue du Genie Militaire</i> 5 Rue des Beaux-Arts, Paris	Monthly Per year 27 fr
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<i>F-15</i>	<i>Revue Militaire des Armees Etrangeres</i> Librairie Chapelot 30 Rue et Passage Dauphine, Paris	Monthly Per year 15 fr
<i>F-16</i>	<i>Yacht, Le, Journal de la Marine</i> 55 Rue Chateaudun, Paris	Weekly Per year 32 fr

## GERMANY

<i>G-1</i>	<i>Artilleristische Monatshefte</i> Mohrenstr. 19, Berlin, W. 8	Monthly Per year 27 M
<i>G-2</i>	<i>Eisen-Zeitung</i> Verlag von Otto Elsner, Berlin, S. 42	Weekly Per year 12 M
<i>G-3</i>	<i>Ingenieur, Der</i> Cordel & Renne, Berlin, W. 15 Charlottenburg 4, 47 Fritschester	Semi-monthly Per year 16 M
<i>G-4</i>	<i>Marine Rundschau</i> Koch Strasse, 68-71, Berlin, S.W.	Monthly Per year 10 M
<i>G-5</i>	<i>Militaer Wochenblatt</i> With monthly Supplement Koch Strasse, 68, Berlin, S.W., 12	3 times a week Per year 18 M
<i>G-6</i>	<i>Schiffbau</i> Zimmerstr. 9, Berlin, S.W., 68	Semi-monthly Per year 20 M
<i>G-7</i>	<i>Stahl und Eisen</i> Dusseldorf 74, Breitstrasse 27	Weekly Per year 30 M
<i>G-8</i>	<i>Ueberall</i> Verlag: Boll und Pickardt Berlin, N.W. 7	Monthly Per year 15.6 M
<i>G-9</i>	<i>Zeitschrift fuer das Gesamte Schiess-und Sprengstoffwesen</i> J. F. Lehmann's Verlag, Munich	Semi-monthly Per year 26 M

## HOLLAND

<i>H-1</i>	<i>Organ of the Association for the Study of Military Science</i> Z. O. Buitsensingel 223 The Hague	Yearly Per year 2 florins
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## ITALY

<i>I-1</i>	<i>Lista Navale Italiana</i> Officina Poligrafica Italiana, Rome	Quarterly Per year 15 L
<i>I-2</i>	<i>Rendiconti delle Esperienze e Degli Studi Eseguiti Nello</i> <i>Stabilimento di Esperienze e Costruzioni Aeronautiche del Genio</i> Viale Giulio Cesare N. 2, Rome	Bi-monthly Per year 13.50 L

*I-3 Rivista di Artiglieria e Genio*  
 Tipografia Enrico Voghera  
 Via Astalli 15, Rome

Monthly  
 Per year 20 L

*I-1 Rivista Marittima*  
 Officina Poligrafica Italiana  
 Rome

Monthly  
 Per year 25 L

## MEXICO

*M-1 Boletin de Ingenieros*  
 War Dept., Mexico City

Monthly

*M-2 Revista del Ejercito y Marina*  
 Departamento de Estado Mayor  
 City of Mexico

Monthly

## NORWAY

*N-1 Norsk Artilleri-Tidsskrift*  
 Christiania

Bi-monthly  
 Per year 6 kr

*N-2 Norsk Militært Tidsskrift*  
 Christiania

Monthly  
 Per year 8 kr

## PERU

*Pe-1 Boletin del Ministerio de Guerra y Marina*  
 Apartado de Correo No. 91, Lima

Fortnightly

## PORTUGAL

*Po-1 Anais do Club Militar Naval*  
 43 Rua do Carmo, Lisbon

Monthly  
 Per year 4\$200

*Po-2 Revista de Artilharia*  
 Rua do Carmo, 43, 2º., Direito, Lisbon

Monthly  
 Per year 3\$000 rs

*Po-3 Revista de Engenharia Militar*  
 27 Rua Nova do Almada, Lisbon

Monthly  
 Per year 3\$600 rs

*Po-4 Revista Militar*  
 Largo da Annunciada, 9, Lisbon

Monthly  
 Per year 3\$000 rs

## RUSSIA

*R-1 Imperial Nicholai War Academy Recorder, The*  
 St. Petersburg

Monthly  
 Per year 6 rubles

## SPAIN

*Sp-1 Informacion Militar del Extranjero*  
 Madrid

Monthly

*Sp-2 Memorial de Artilleria*  
 Museo de Artilleria, Madrid

Monthly  
 Per year 18 ps

*Sp-3 Revista Cientifico-Militar*  
 Paseo de San Juan, 201, Barcelona

Semi-monthly  
 Per year 40 ps

*Sp-4 Revista General de Marina*  
 Ministerio de Marina, Madrid

Monthly  
 Per year 25 ps

## SWEDEN

*A-1 Artilleri-Tidsskrift*  
 Artillerigarden, Stockholm

Bi-monthly  
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## SWITZERLAND

<i>Sd-1</i>	<i>Allgemeine Schweizerische Militaer-Zeitung</i> Basel	Weekly Per year 10 fr
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<i>Sd-4</i>	<i>Schweizerische Zeitschrift fuer Artillerie und Genie</i> Frauenfeld	Monthly Per year 8 fr

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<i>UK-12</i>	<i>Journal and Proceedings, Royal Society N. S. W.</i> 5 Elizabeth St., North Sydney, N. S. W.	
<i>UK-13</i>	<i>Journal of the Royal United Service Institution</i> Whitehall, London, S.W.	Monthly Per year 21s
<i>UK-14</i>	<i>Journal of the United Service Institution of India</i> Simla, India	Quarterly Per year Rs 8

UK-15	<i>Junior Institution of Engineers, The</i> 39 Victoria St., Westminster, S. W. London	Single copy 1s
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UK-19	<i>Proceedings of the Institution of Civil Engineers</i> Great George St., Westminster, London, S. W.	
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UK-21	<i>Royal Engineers Journal, The</i> Chatham	Monthly Per year 15s
UK-22	<i>Transactions of the Canadian Institute</i> 58 Richmond Street, Toronto, Canada	
UK-23	<i>Transactions of the Canadian Society of Civil Engineers</i> Montreal, Canada	
UK-24	<i>Transactions of the Institution of Naval Architects</i> 5 Adelphi Terrace, London, W. C.	
UK-25	<i>United Service Gazette</i> 43, 44 Temple Chambers London, E. C.	Weekly Per year £1 10s 6d
UK-26	<i>United Service Magazine</i> 23 Cockspur Street, Charing Cross London, S. W.	Monthly Per year £1 1s

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US-1	<i>Aeronautics</i> 250 West 54th Street, New York City	Monthly Per year \$3.00
US-2L	<i>American Historical Review</i> The Macmillan Company 41 N. Queen Street, Lancaster, Pa., or 66 Fifth Avenue, New York City	Quarterly Per year \$4.00
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US-4	<i>American Journal of Mathematics</i> Johns Hopkins Press Baltimore, Md.	Quarterly Per year \$5.00
US-5	<i>Arms and The Man</i> 1502 H Street, N.W., Washington, D. C.	Weekly Per year \$3.00
US-6	<i>Army and Navy Journal</i> 20 Vesey Street, New York	Weekly Per year \$6.00
US-7	<i>Army and Navy Register</i> Washington, D. C.	Weekly Per year \$3.00
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<b>US-19</b>	<b><i>Confederate Veteran</i></b> Nashville, Tenn.	Monthly Per year <b>\$1.00</b>
<b>US-20</b>	<b><i>Craftsman, The</i></b> 41 W. 34th Street, New York	Monthly Per year <b>\$3.00</b>
<b>US-21</b>	<b><i>Electric Journal, The</i></b> 200 Ninth Street, Pittsburgh, Pa.	Monthly Per year <b>\$1.50</b>
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<b>US-24</b>	<b><i>Engineering Magazine, The</i></b> 140-142 Nassau Street, New York	Monthly Per year <b>\$3.00</b>
<b>US-25</b>	<b><i>Engineering News</i></b> 505 Pearl Street, New York	Weekly Per year <b>\$5.00</b>
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<b>US-27</b>	<b><i>Field Artillery Journal, The</i></b> U. S. Field Artillery Association 1701 Pennsylvania Avenue, N.W. Washington, D.C.	Quarterly Per year <b>\$1.00</b>
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<b>US-30</b>	<b><i>Infantry Journal</i></b> U. S. Infantry Association 814 Seventeenth Street, N.W. Washington, D. C.	Bi-monthly Per year <b>\$3.00</b>



US-31L	<i>Journal of American History, The</i> 3 West 43rd Street, New York	Quarterly Per year \$3.00
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US-40	<i>Journal of the Western Society of Engineers</i> 1735 Monadnock Block Chicago, Illinois	Monthly ex. July and Aug. Per year \$3.00
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US-51	<i>Polytechnic, The</i> Troy, N. Y.	10 Nos. per yr. Per year \$2.00
US-52	<i>Popular Mechanics</i> 318 West Washington Street, Chicago, Ill.	Monthly Per year \$1.50
US-53	<i>Practical Electricity and Engineering</i> 608 South Dearborn Street, Chicago, Ill.	Monthly Per year \$1.00
US-54L	<i>Proceedings of the American Institute of Electrical Engineers</i> 33 West 39th Street New York	Monthly Per year \$10.00
US-55	<i>Proceedings of the American Philosophical Society</i> 104 South Fifth Street, Philadelphia, Pa.	
US-56	<i>Proceedings of the American Society of Civil Engineers</i> 220 West 57th Street New York	Monthly Per year \$8.00
US-57	<i>Proceedings of The Engineers' Club of Philadelphia</i> 1317 Spruce Street Philadelphia, Pa.	Quarterly Per Vol. \$2.00
US-58	<i>Proceedings of The Engineers' Society of Western Pennsylvania</i> 2511 Oliver Building Pittsburgh, Pa.	10 Nos. per year Per year \$5.00
US-59	<i>Proceedings of the U. S. Naval Institute</i> Annapolis, Md.	Quarterly Per year \$3.00
US-60	<i>Professional Memoirs</i> Washington Barracks, D. C.	Bi-monthly Per year \$3.00
US-61	<i>Reactions</i> Goldschmidt Thermit Company 90 West Street, New York	Quarterly Per year \$0.25
US-63	<i>Science</i> 41 North Queen Street, Lancaster, Pa.	Weekly Per year, \$5.00
US-64	<i>Science Conspectus</i> Massachusetts Institute of Technology Boston, Mass.	Five issues per yr.
US-65	<i>Scientific American, The</i> 361 Broadway, New York	Weekly Per year \$3.00
US-66L	<i>Scientific American Supplement</i> 361 Broadway, New York	Weekly Per year \$5.00
US-67	<i>Scientific Digest, The</i> Kansas City Life Building Kansas City, Mo.	Monthly Per year \$1.00
US-68	<i>Seventh Regiment Gazette, The</i> 30 West 33rd Street, New York	Monthly Per year \$1.50
US-69	<i>Shots</i> National Guard Armory Minneapolis, Minn.	Monthly Per year \$1.00
US-70	<i>Southern Electrician</i> Cotton Publishing Co., Atlanta, Ga.	Monthly Two yrs. \$1.00
US-71	<i>Stevens Institute Indicator</i> Hoboken, N. J.	Quarterly Per year \$1.50
US-72	<i>Technical World Magazine</i> 5758 Drexel Avenue, Chicago, Ill.	Monthly Per year \$1.50
US-73	<i>Telephone Engineer</i> Monadnock Building, Chicago, Ill.	Monthly Per year \$2.00

- US-74 Transactions of the American Society of Civil Engineers*  
220 West 57th Street, New York Quarterly  
Per year \$12.00
- US-75 Transactions of the Society of Naval Architects and Marine Engineers*  
29 West 39th Street, New York
- US-76L Virginia Magazine of History and Biography, The*  
Virginia Historical Society Quarterly  
Richmond, Va. Per year \$5.00

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A lady's experiences in the great siege of Gibraltar (1779-83)—UK-5, October, 12.

Military letters of Captain Joseph Shippen of the Provincial Service, 1756-1758—US-49, July, 12.

The Portuguese in the Peninsular War—Po-4, September, 12.



Recollections in Portugal and Spain during 1811 and 1812—UK-13, November, December, 12.

The Russo-Japanese war—US-37, January-February, 13.

The siege of Gibraltar—UK-21, January, 13.

The Vimeiro campaign—UK-3, January, 13.

*General:*

The American Civil War and its meaning to us (Swiss)—Sd-1, Dec. 7, 12.

Cornwallis in North Carolina—US-31L, 2d. quarter, 12.

Extensive attacks and their application in the Russian-Japanese war—G-6, November 14, 12.

Historical development of the military situation in England—G-5, September 19, 12.

History of the squadron of Marques de Niza—Po-4, September, 12.

Kuropatkin and his subordinates—G-5, October 1, 12.

Mexican diplomacy on the eve of war with the United States—US-2L, January, 13.

Old Fort Laramie—US-37, January-February, 13.

Orderly book of the Second Pennsylvania Continental Line—US-49, July, 12.

Papers of Field Marshal Sir John Burgoyne—UK-21, January, 13.

Sir Henry Green and the Sind frontier—UK-13, November, 12.

The question of arming the slaves—US-2L, January, 13.

The significance of the study of military history—H-1, October, 12.

Stuart's cavalry in the American war of secession—G-6, November 19, 12.

*Naval:*

The battle of Tsushima—I-4, November, 12.

Decline of Holland's naval power—F-14, August, 12.

Naval operations of the Russo-Japanese War—Br-3, September, October, 12.

The office of admiral in the French navy up to the time of Cardinal Richelieu—F-14, September, 12.

The ministry of marine under the old régime—F-14, August, September, 12.

*Recent:*

The activity of the Italian navy during the Italo-Turkish war, 1911-12—G-4, December, 12.

The Balkan war of 1912—UK-26, December, 12, January, 13; Sd-2, December, 12; F-16, November, 12.

The belligerent armies in the Balkan war—Sp-2, November, 12.

The defeat of the Turks—S-1, November 9, 12.

The German guns and the Balkan war—G-6, November 26, 12.

The importance of Adrianopole as a fortress—G-5, December 12, 12.

Italian-Turkish war—US-59, December, 12.

The Italo-Turkish war of 1911-12 (up to May 20)—F-11, September, 12.

Lessons from the war (Balkan-Turkish)—S-1, November 30, 12.

The overthrow of the Turkish army—S-1, November 2, 12.

Some notes on the Balkan war, 1912—UK-3, January, 13.

The war in the Balkans—I-4, October, November, 12; Sd-2, November, 12; US-37, January-February, 13.

The war in the Balkan Peninsula. Military operations, naval operations, political—UK-13, December, 12.

The war in the Balkan Peninsula. The preliminaries; war organization; narrative of operations; naval operations; maps—UK-13, November, 12.

The War on the Balkan Peninsula during 1912—Au-3, November, 12.

The war in the Mediterranean—UK-5, October, 12.

War in the Mediterranean. Action near Misurata; occupation of Zuara; capture of Captain Moizo; casualty list; communications; Turkish military measures; Derna; second battle of Zanzur; occupation of Bomba; cost of war; Italian forces in October; peace treaty—UK-13, November, 12.

#### HORSES

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 Fort Keogh remount depot—US-39, January, 13.  
 Hints on the treatment of horses—UK-5, October, 12.  
 The most suitable type of horse for field artillery—US-27, Oct.-Dec., 12.  
 On shoeing (a horse)—G-5, September 19, 12.  
 The Saumur horse-show of 1912—F-11, November, 12.  
 Supplying the army with horses—US-5, December 5, 12.

#### HYGIENE AND SANITATION

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 Military hygiene—F-4, November 15, 12.  
 Military hygiene—hospital service in the field—Pe-1, October, 12.  
 Portable water distillers for the army in Germany—Sd-1, September 21, 12.  
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 Instruction of the German infantry—Sp-1, November, 12.  
 The role of cycle companies and mounted infantry in reconniassance and combat—Pe-1, October, 12.  
 Short notes on the new service regulations for infantry—Br-1, Nov., 12.  
 A short plea in favor of the present organization of the infantry battalion—UK-13, November, 12.

#### LANDING OPERATIONS

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##### *Military:*

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 Courts martial of the Peninsular war, 1809-14—UK-13, December, 12.  
 A military trial under the old régime: the affair "du Regiment Royal-Comtois"—F-4, December 15, 12, January 1, 13.  
 A military trial under the old regime—F-4, December 1, 12.

##### *Municipal:*

Australia and the universal training law—UK-3, January, 13.

#### LEGISLATION, NEW

Proposed organization of the cavalry and the order of May 28, 1895, relative to field service—F-11, December, 12.

#### LOGISTICS

On the value and application of reserve supplies in field warfare—Au-3 November, 12.

Japanese service of the line of communication—Sp-2, November, 1912.

#### MACHINE GUN ORGANIZATIONS

Machine guns in future wars—Au-2, October, 12.

#### MANEUVERS

##### *Field:*

The army maneuvers in the west of France—Be-1, December 8, 12.

The artillery in the 1912 maneuvers of the twelfth division—F-4, November 15, December 1, 12.

Autumn exercises of the 14th Division, German army—C-1, October, November, 12.

The autumn maneuvers of a German army corps—US-30, November-December, 12.

Aviation at the French maneuvers—US-30, November-December, 12.

Cavalry maneuvers under General Sordet—F-11, December, 12.

Comments on the last French grand maneuvers—Sp-3, November, 12.

Details of maneuvers—Sd-2, November, 12.

Joint maneuvers—Connecticut—US-5, December 19, 12.

The large French maneuvers—professional study—Pe-1, October, 12.

Latest on the French army (review of the maneuvers)—G-5, October 8, 12.

Maneuver impressions—UK-26, December, 12.

The maneuvers of the 5th and 6th divisions of the Swiss army in 1912—F-15, December, 12.

The Swiss fall-maneuvers (1912)—G-5, September 26, 12.

Maneuvers of the 9th Division of the Brazilian army in September, 1912—Ar-2, October, 12.

Mounted artillery in the last maneuvers—Br-1, November, 1912.

Problems of a national guard regimental surgeon on a maneuver campaign—US-43, January, 13.

Programme for 1912 maneuvers—Br-1, October, 12.

The second cavalry maneuver—F-11, November, 12.

Remarks on the maneuvers of the French army in 1912—Sd-2, November, 12.

Some practical remarks relative to a day of maneuvers—F-11, November, 12.

Umpiring in France—US-37, January-February, 13.

##### *Naval:*

The French fleet maneuvers from November 5 to 8, 1912—G-1, Dec., 12.

The French naval maneuvers, 1912—G-1, October (No. 10), 12.

The French naval maneuvers in the Mediterranean during 1912—Au-1, No. 10, 12.

#### MATERIAL, MISCELLANEOUS

Austrian observation ladder and bridge equipment—US-27, October-December, 12.

The development of the Le Boulengé chronograph—G-9, December 15, 12.

The manufacture of manila rope. Its use for transmission and hoisting—US-66L, December 28, 12.

The Von Löbell reports on military matters in 1911—UK-13, December, 12.

Von Löbells' reports for 1911—US-37, January-February, 13.

Workshop for adjusting and repairing optical instruments, telephones, etc.—C-1, November, 12.

## MEDICAL DEPARTMENT

The advantages accruing to the National Guard from tours of duty with the regular establishment like that at Sparta, Wisconsin, in 1912—US-43, January, 13.

The Medical Department of the United States Army in the Civil War. Pope's Virginia Campaign—US-43, December, 12, January, 13.

Medical report of the Mexican army—M-2, November, 12.

Medical service in the field—US-38, November-December, 12.

The naval surgeon—Br-3, October, 12.

The naval surgeon and his duties—C-2, October, 12.

A new travois: A plea for its addition to the equipment of ambulance companies—US-43, December, 12.

Notes on organization and equipment for evacuation of the wounded—US-43, December, 12.

Preparedness of the Medical Department of the army, in the matter of field medical supplies—US-43, January, 13.

Problems of a national guard regimental surgeon on a maneuver campaign—US-43, January, 13.

## METALLURGY

Method of producing sound ingots—UK-17, November 22, 12.

On a new method of revealing segregation in steel ingots—UK-17, November 22, December 20, 12.

## MILITIA

Militia of one year and recruitment of reserve officers—Be-1, Dec. 29, 12.

## MINES

*Submarine:*

Capt. Elia's (Italian Navy) system of automatic (contact) submarine mines—Sp-1, October, November, 12.

Submarine mines in naval operations—Po-1, August, 12.

Submarine mines—Po-1, August, 12.

## NAVAL CONSTRUCTION, GENERAL (SEE ALSO WARSHIPS)

Notes on inspection duty at shipbuilding works—US-59, December, 12.

Armor and ships. A brief résumé of twenty years progress and its effect on coast defense—US-38, November-December, 12.

The corrugated ship—UK-13, November, 12.

Engineering progress in the U. S. Navy—US-7, December 28, 12.

Electricity in the navy—US-22, November 7, 12.

Evolution of recent types of men-of-war and their tactical employment—F-14, August, 12.

The German naval architects—UK-8, November 29, 12.

Modern painting methods in the navy—US-66L, December 7, 12.

Navy yards as manufacturing establishments, and the cost of manufactured articles—US-59, December, 12.

New electrical apparatus for warships—Au-1, No. 12, 12,

On shearing stress in a ship's structure—UK-9, December 27, 12.

Some military principles which bear on warship design—US-38, November-December, 12.

The ultimate dimensions of the largest sea-going vessels—UK-17, Jan. 3, 13.

## NAVIES, BY COUNTRY

*Brazil:*

The rejuvenation of the Brazilian naval squadron—Br-3, October, 12.

*France:*

On the creation and use of the grade of “capitaine de corvette” (lieutenant commander)—F-14, September, 12.

*Japan:*

The formidable power of the Japanese navy—C-1, November, December, 1912.

*Portugal:*

Reorganization of the Portuguese navy—Po-1, August, 12.

*United Kingdom of Great Britain and Ireland, Its Colonies and Possessions:*

Creation of a naval general staff in England—C-2, November, 12.

The naval year—UK-2, January 4, 13.

*United States of America:*

Engineering progress in the U. S. Navy—US-75, November 21, 22, 12.

*Other countries:*

A very good or bad naval project—Sp-4, October, 12.

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## NAVIGATION

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The compass in protected places—I-4, October, 12.

The determination of a ship's position at sea by wireless—UK-17, January 3, 13.

The factor of assurance. A means of making the best of your way at sea—US-34, November, 12.

Guide for the officer in charge of the compass—F-14, August, 12.

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Notes on fuel economy as influenced by ship design—US-75, Nov. 21, 22, 12.

Orthodromic navigation (laying course on arc of great circle)—Br-3, Oct., 12.

The ship's course. (Examination in pilotage—Admiralty instructions)—C-2, November, 12.

Ship-building and seamanship in England—G-8, October, 12.

Ship propulsion by electricity—UK-17, December 6, 12.

Some remarks on the compass—F-16, December 11, 12.

Speed of boats—Ar-1, September-October, 12.

The Sperry gyro-compass in service—US-75, November 21, 12.

Seamanship of modern men-of-war—Sp-4, October, November, 12.

Study of the Sperry gyroscopic compass—F-14, September, 12.

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Workshop for adjusting and repairing optical instruments, telephones, etc.—C-1, November 19, 12.

## ORDNANCE CONSTRUCTION, MISCELLANEOUS

The centenary of the Krupp works—Be-2, September-October, 12.

The Fried. Krupp steel works, Annen—UK-9, December 27, 12.

The increase of caliber and the one projectile—Br-3, September, 12.

The Krupp works once more—Sd-2, December, 12.

Lectures to young gunmakers—UK-1, January, 13.

The ordnance designers—F-10, October, 12.

ORGANIZATION, AT LARGE (SEE ALSO ARMIES AND NAVIES BY COUNTRY)

*Army:*

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Ideas on the organization of artillery—Sp-2, October, 12.

Military reorganization of Austria-Hungary—F-15, November, 12.

On organization: cavalry divisions—F-11, November, 12.

Organization of the Turkish army—Sp-1, November, 12.

Questions on artillery reorganization—G-1, December, 12.

Reorganization of the technical troops in Austria-Hungary—Sd-4, Dec., 12.

A short plea in favor of the present organization of the infantry battalion—UK-13, November, 12.

Team play—US-30, November-December, 12.

Von Löbell's reports for 1911—US-37, January-February, 13.

*Navy:*

Creation of a naval general staff in England—C-2, November, 12.

PHILOSOPHY AND PSYCHOLOGY

Mental and moral training for war—US-59, December, 12.

Moral education in the Japanese army—Pe-1, October, 12.

National culture and the love of the flag—Sp-3, November, 12.

National life and national training—UK-3, January, 13.

Psychology of the commander in chief—Br-1, October, November, 12.

War and the survival of the fittest. Does physical conflict between the nations select the highest type?—US-66L, January 4, 11, 13.

PHYSICS (ESPECIALLY MECHANICS, HEAT AND SOUND)

Active type of stabilizing gyro—US-75, November 21, 12.

The manufacture of manila rope. Its use for transmission and hoisting—US-66L, December 28, 12.

The strength of gear teeth—US-33, January, 13.

POLITICS AND POLICY

The budget of the German empire for 1912-1913—F-15, December, 12.

Colonel Seely on compulsory service—UK-25, December 12, 12.

France and the Mediterranean—UK-26, January, 13.

The fusion of Great Britain and its importance relative to British naval strategy—G-8, December, 12.

The German menace to English naval supremacy—F-14, August, 12.

The German North Sea coast line in the light of English espionage—G-8, December, 12.

Imperial naval policy—UK-26, January, 13.

The Lord of the Sea. (Study of the results if Napoleon had been master of the sea.)—C-2, November, 12.

The Mediterranean Sea and the world policy—G-8, October, 12.

The military policy and institutions of the British Empire—UK-26, December, 12, January, 13.

The national reserve—UK-26, December, 12.

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Secrecy in the present (Turko-Bulgar) war—Sp-3, November, 12.

A sinister forecast—UK-26, January, 13.

Two solutions of the eastern problem—US-45L, November, 12.  
 The speech of the first lord of the (British) admiralty—F-14, September, 12.  
 The struggle for sea power. The navy of France, in the past and to-day—  
 UK-26, January, 13.

#### PRACTICAL TRAINING

##### *Coast Artillery:*

A scheme for the training of a company of coast artillery for field work in connection with the land defense of sea coast fortifications—US-38, November-December, 12.

##### *Mobile Army:*

A graphical means of avoiding some computations in topography and artillery—UK-5, October, 12.

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Memorandum on army training in India, 1911-12—UK-3, January, 13.

Training the one-year volunteer of infantry—G-5, October 1, 12.

##### *Naval:*

Outline of reorganization for training the gun pointer in the French navy—G-4, (No. 10.) October, 12.

##### *Miscellaneous:*

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Field firing in the organized militia—US-30, November-December, 12.

#### PROJECTILES

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The explosion of a Chilean "universal projectile" in the Krupp works—C-1, November, 12.

An infantry fire-shell (capable of setting fire to) and its importance in fighting airships—G-9, December, 12.

Importance, and method of employing luminous projectiles—Po-2, September, 12.

Notes on the time fuze applied to fire with the universal projectile—C-1, October, November, 12.

A tabular compilation of patents at home and abroad relative to projectiles which serve for the destruction of airships—G-9, December 1, 12.

#### RADIO-TELEGRAPHY AND RADIO-TELEPHONY

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The International Radio Conference of London—US-31, November, 12.

Military cryptography—UK-13, December, 12.

The ordinary *versus* the quenched spark in wireless telegraphy—UK-21, January, 13.

Practical signaling by modern radiotelegraphic apparatus (1912)—I-4, October, 12.

Signaling by radiotelegraphy in general and its military uses—I-3, Sept., 12.

The telefunken (wireless sets) in the Balkan war—G-5, December 3, 12.

#### RECONNAISSANCE AND SKETCHING

Aerial photo-topography. Method of Schempfling (Captain Austrian Army) for the construction of a photo-map—Ar-2, September, 12.

A graphical means of avoiding some computations in topography and artillery—UK-5, October, 12.

Military map reading—Be-2, September-October, 12.

Practical topography—UK-26, December, 12.

The role of cycle companies and mounted infantry in reconnaissance and combat—Pe-1, October, 12.

Two difficulties in military sketching—UK-26, December, 12.

#### RESERVES

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#### SCHOOLS

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The U. S. Naval Academy. An undergraduate's point of view—US-59, December, 12.

#### SEARCHLIGHTS

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#### SIEGE ARTILLERY

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#### SIEGE OPERATIONS

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The case of the R.G.A. (coast defense) signaler—UK-11, December, 12.

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#### SMALL ARMS

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Firearms in the Turko-Bulgar war—Sp-3, November, 12.

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The Napoleon maneuver in cavalry combat—F-4, December 1, 12.

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The strategic employment of cavalry (Russo-Japanese war)—Sp-3, Oct., 12.

*Field Artillery:*

Action of artillery in the attack of a modern fort especially in mountainous country—I-3, September, 12.

The artillery in battle. The action of 6th August, 1870—UK-11, Dec., 12.

Artillery support to the infantry attack—US-27, October-December, 12.

Signs showing the transformation in the employment of artillery in France—G-1, December, 12.

The strength of gear teeth—US-33, January, 13.

Tactical artillery problems—Sd-4, November 9, 12.

Tactics of the Russian field artillery—G-5, December 12, 12.

*General:*

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Heretical doctrines of war—UK-26, January, 13.

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Remarks on the German strategy in the war against the Hereros—F-4, November 15, 12, December 1, 15, 12.

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Strategical position of Great Britain in a maritime war: (1) if Ireland were neutral; (2) if Ireland were hostile (Ellenborough prize essays)—UK-26, December, 12.

Tactical problems—F-1, November 15, 12.

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Von Löbell's reports for 1911—US-37, January-February, 13.

*Infantry:*

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The struggle for sea power. The navy of France, in the past and to-day—UK-26, December, 12.

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 Salvage and testing facilities for submarines—US-65, November 23, 12.  
 The *Vendemiaire*. (French submarine sunk by collision)—C-2, October, 12.

#### SUPPLY DEPARTMENTS (SEE ALSO LOGISTICS)

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 The military employment of motor-wagons—II-1, November, 11.  
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#### TARGETS AND TARGET PRACTICE

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##### *Small arms:*

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 Setting forth the advantages of the electric targets of the Brewer system—  
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 The use of the "sub-target" in small arms practice—C-1, December, 12.

#### TECHNICAL TROOPS (ENGINEERS, SIGNAL, ETC.)

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 (1495)—Au-2, No. 12, 12.  
 Work of the 26th battalion of engineers along the Algiers-Morocco boundary  
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#### TELEGRAPHY

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 Military telegraph service—Po-3, April, 12.  
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 Study of the telegraph and telephone, and its use in the field—M-1, Dec., 12.

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The Austro-Hungarian system of field telephones for field artillery—C-1,  
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 The loading of submarine telephone cables—UK-7, November 29, 12, Decem-  
 ber 13, 12.  
 Study of the telegraph and telephone and its use in the field—M-1, Dec., 12.

#### TELESCOPES, GLASSES, AND TELESCOPIC INSTRUMENTS

Defects of optical instruments. (Abstract of article by Captain Glen F.  
 Jenks, C. A. C., published in the Journal U. S. Artillery for January-Feb-  
 ruary, 12; Be-2, September-October, 12.

#### TORPEDO BOATS AND DESTROYERS

The torpedo boat destroyer. What it is and what it should be in the light  
 of the Russo-Japanese war—F-11, August, 12.  
 Undertakings of the Japanese torpedo boats in the war against Russia;  
 results and lessons—G-1, December, 12.

## TORPEDOES

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## UNIFORM CLOTHING

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*France:*

Increase in the (French) naval program—F-16, December 7, 12.

*Japan:*

The formidable power of the Japanese navy—C-1, October, 12.

*Portugal:*

The armament of our future battleships—Po-1, October, 12.

*United Kingdom of Great Britain and Ireland, Its Colonies and Possessions:*

Ship-building and seamanship in England—G-8, October, 12.

*United States of America:*

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The launching of the *New York*—US-59, December, 12.

Rudder trials, U. S. S. *Sterrett*—US-75, November 21 and 22, 12.

Use of fuels in the United States Navy—US-34, November, 12.

U. S. Fleet collier *Orion*. Description and trials—US-34, November, 12.

U. S. S. *Arkansas* contract trials performance—US-34, November, 12.

U. S. S. *Fanning* contract trials performance—US-34, November, 12.

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Conference on obligatory military service—C-1, October, 12.

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# JOURNAL

OF THE

## UNITED STATES ARTILLERY

*“La guerre est un métier pour les ignorans  
et une Science pour les habiles gens.”*

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### WHAT HAS BEEN DONE SINCE 1892 FOR THE DEFENSE OF OUR COAST LINE OUTSIDE THE COAST FORTS

BY LIEUTENANT-COLONEL WILLIAM G. HAAN, GENERAL STAFF,

AFTER CONSULTATION WITH

MAJOR-GENERAL W. W. WOTHERSPOON, U. S. ARMY,

PRESIDENT NATIONAL LAND DEFENSE BOARD

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For reasons not necessary to explain to the officers of our service, the introduction of rifled cannon required radical changes in the character of coast fortifications. With the advent of these guns our elaborate system of masonry fortifications became useless. We were thus confronted with the problem of planning a system of defenses capable not only of resisting the penetrating power of these new weapons, but of resisting the penetrating power of all probable improvements thereof.

At the time the new system of defenses had to be planned the United States was provided, in the veterans of the Civil War, with a reserve of trained personnel, so large and so excellent that the question of an invasion by a foreign country was so little thought of that in planning the new defenses the problem of land defense for the coast forts was totally lost sight



of. In none of the discussions that are now available can be found a reference to anything relating to that part of the defense.

In the system of coast fortifications previous to the present one, provision was made for complete defense against attacks from the land side. In many of them heavy guns were faced landward. Old Fort Tompkins at Fort Wadsworth, New York Harbor, is probably one of the best remaining examples of the old type. Two forts are here located. One is situated on a hill one hundred and forty feet high, directly in rear of another, which is on the sea level. In the one on the hill, provision is made for quartering all the troops necessary to man the armament of the two forts. This fort contained heavy guns covering all approaches, land and sea. Some of those covering the land side could not be used seaward.

By such a construction, the fort garrison could take care of itself against land attack, even though only sufficient men were available for manning the heavy guns.

The present system of fortifications, planned perhaps at an unfortunate time when only one phase of the problem strongly presented itself, consists, in general, of batteries scattered over considerable areas. They are so located that it is impossible to plan gorge defenses such as were provided in the previous system of fortifications.

At the close of the Civil War our navy held, among the nations of the earth, a very high place. For a long period after that war it was, however, wholly neglected; and it was soon completely surpassed by those of many European nations, some of which—England, Germany, and France—organized fleets of subsidized steamers suitable for troop transports. Our army also had been sadly neglected; and in due course of time it became apparent to thoughtful statesmen and their military advisers that the preparations of European nations were so organized as to be capable not only of controlling the sea with their fleets, but also, with the aid of subsidized transports, of quickly landing in foreign countries their well trained armies. The disposition of our coast defenses was well known to European nations, and it was also known to them that these defenses were unprotected on the land side.

At the time of our war with Spain the installation of our new armament had just begun. In each of our important harbors a few guns had been mounted; and, although in this war our superior navy lessened the danger of an attempt on the part

of the enemy to land on our shores, it was deemed necessary to assign troops to protect our fortifications against possible attack from the land side. On the Atlantic coast alone some sixteen regiments were assigned to this duty. It was not until this late date that our people came to realize that the veterans of the Civil War were no longer available to protect the country from invasion, and that there were no trained men to take their places.

When the modern batteries were turned over to the coast artillery troops, the officers quickly noted their defenseless condition on the land side and began to study the problem of land defense. It was not long before it became evident that the personnel assigned for manning the armament would be unable to protect itself against even the smallest attacking parties. The question of the probability of an enemy with a superior navy attempting such an attack, which at the time the fortifications were planned was wholly disregarded, now began to be considered seriously, and with further study was admitted by army and navy officers as the one having for the enemy the greatest chances of success.

We find reference to this in the first coast artillery drill regulations issued for the new armament in 1898. We find it for the first time taking a prominent place in annual exercises in the Army and Navy Maneuvers of 1903, at Portland, Maine, where an attempt was made by a landing party to capture the guns at Fort Williams. In this maneuver elaborate preparations had been made and detailed instructions formulated for defending the land side of the forts by mobile troops. These plans had to be hastily made, and more than double the number of troops were called for in the plans than would have been necessary had there been time for deliberately selecting the best natural positions and having working plans made for their defense.

When the General Staff Corps was created by law in 1903, among its most important duties as prescribed by law was the *making of plans for the national defense*. The first action, so far as known, was taken by the General Staff at a meeting of the War Department General Staff in 1904. At that meeting Captain Dennis E. Nolan, then a member of the Information Division, brought up the question of securing better maps of the country in the vicinity of our fortified harbors. The matter of the necessity for such maps in connection with the preparation of plans for protecting our coast fortifications against

land attack, was at that meeting discussed at some length by the officers present. No definite steps, however, were taken, so far as known, actually to secure such maps. The next year a beginning was made on the Pacific coast by the writer, who had been sent there as Assistant to the Chief of Staff. Problems were formulated and sent to the various artillery district commanders with instructions to assign them to committees of officers in their districts for post graduate garrison school work. The problems were specific in their nature, and not only covered attacks on the coast forts, calling for plans of defense, but also included the mobilization, equipment, and transportation of the Organized Militia and volunteer troops in the states on the Pacific coast. At the close of the school year of 1905-6 a report was made as to what had been done in that line on the Pacific coast. A copy of this report was sent to the President of the Army War College, then Brigadier General Thomas H. Barry, with a request to know whether the work was in accordance with his views and in line with the work that was being done at the Army War College. A reply was received that it was in harmony with theoretical studies then being made at the Army War College, and we were encouraged to continue our work on the Pacific coast.

In the War College year 1905-6 a committee of general staff officers under Major Geo. W. Goethals made a theoretical study as best could be done from the available maps and data. The problem of this committee was, to "Make Plans for the Protection of Seacoast Forts from Attack by Land." In its study the committee concluded that for each fortress the solution of the problem requires the determination of: (1) the position of a defensive line and the character of the works composing it, and (2) the number and kinds of troops necessary for proper defense; and further, that in determining the position of the line accurate topographic maps to suitable scale are essential, but that such maps were wanting. The committee made recommendations as to what steps should be taken to obtain appropriate maps.

The work of this committee may be considered the first systematic work done looking to the preparation of comprehensive plans for the protection of our modern coast forts against land attack. Much work had been done, it is true, by local engineer officers and by the Engineer Board, but a study of the projects so prepared indicated a total lack of coordination. They were based upon specific assumptions for each

locality, and were not the result of a general study. All projects that had been prepared were referred to the War College committee and proved of much assistance to it in the more general study of the problem.

The report of the committee was approved by the President of the Army War College and submitted to the War Department with suggestions for securing for its archives, in time of peace, detailed working plans for protecting the seacoast fortifications against land attack in time of war. It was recommended that the plans as tentatively drawn by the War College be sent to division commanders concerned, instructing them to have the terrain in each instance carefully examined by competent officers, with a view to confirming or modifying the locations for defensive works indicated, and to selecting and locating suitable camp sites; and further, that division commanders be directed to have surveys made and maps prepared of the several defensive areas. It was also recommended that the report be referred to the Chief of Engineers and the Chief of Artillery for suggestions from them as to the best methods of accomplishing the desired results.

The Acting Chief of Artillery, Lieutenant Colonel Arthur Murray, on September 15, 1906, submitted a memorandum in which he stated in part as follows:

After careful consideration I am confident that more uniform and much better results will be obtained with respect to the special work desired to be done under direction of division commanders in connection with the solution of the problem of the "protection of seacoast forts from attack by land" if the "competent officers" needed for this special work are detailed by the War Department than if they are left to selection by the different division commanders as suggested. I therefore inclose a draft of a special order which I recommend be issued by the War Department detailing certain officers whom I consider "competent" for this special work and prescribing in general terms their duties in connection therewith.

Colonel Murray in his memorandum discussed in a general way the report that had been adopted by the War College, and made recommendations as to the organization of the troops and as to certain small bodies of troops that would be necessary at all times during war for protecting the forts against small raiding parties. These recommendations were carefully considered by the War Department and concurred in after consultation with the President of the Army War College.

As a result of this discussion and subsequent conferences, an order was issued on March 18, 1907, as follows:

SPECIAL ORDERS, }  
No. 64. }

WAR DEPARTMENT,  
WASHINGTON, *March 18, 1907.*

Extract.

\* \* \* \* \*

18. Boards of officers are appointed to meet in all artillery districts for the purpose of considering questions pertaining to the protection of seacoast forts from attack by land.

*Detail for each board.*

Lieut. Col. Wm. W. Wotherspoon, General Staff.

Captain Wm. G. Haan, Artillery Corps.

The artillery district commander.

The district engineer officer.

The boards thus constituted will convene in the several artillery districts and begin the work as soon as practicable and will be governed by such special instructions as they may receive from the War Department.

\* \* \* \* \*

BY ORDER OF THE ACTING SECRETARY OF WAR:

WILLIAM P. DUVALL,

Brigadier General,

Acting Chief of Staff.

By paragraph 2, General Orders, No. 209, War Department, 1909, the designation was changed to the "National Land Defense Board." The permanent members of this board, Brigadier General W. W. Wotherspoon and Lieutenant Colonel W. G. Haan, have served continuously on the board from its organization until the present time.

In order that there might be a full understanding as to the scope of the plans which the board was now undertaking, it submitted a statement, after more than a year's work and study, giving its views as to the limitations, etc., of the plans that were to be prepared. This statement was carefully considered by the Chief of Staff and approved by the Secretary of War November 24, 1908. The board has continued work under these instructions until the present time.

Due, perhaps, to a somewhat faulty wording in several of the projects, and due to an equally faulty study, several officers have sadly mixed the plans for constructing defensive works, camps, etc., *with the handling of the troops.* That is a proper function of the commander of the troops and not of a fortification board. *There is nothing in the projects pretending to dictate to the commander the manner in which he should fight his command.* The principles by which the board was guided in the preparation of plans are not materially different from those governing

the selection of positions and fortifying them for an active field army operating on somewhat limited ground. It must not be assumed that the War Department instructions to the board indicate, nor that the ideas of the board are, that a merely passive defense should be made. In most places the problem is one requiring an active defense, and *the plans are so drawn as not to restrict in any way the free movements of the troops.*

As a result of such comprehensive studies in time of peace, the War Department, when in time of war it assigns a commander, is enabled to give him, in addition to the troops assigned to his command, carefully selected camps, carefully prepared maps, and auxiliary fortifications covering important approaches to fortifications or other important points, and the fullest information regarding the nature of the surrounding country. Also, at that time, the War Department, knowing better the probable nature of attacks that may be expected and the character of coordinate commands, *can give all necessary general instructions to the commander; but the project is no place for such instructions.*

The general method of procedure has been for the members of the board, after collecting the best obtainable maps, to visit the locality under consideration, make a careful study of the ground, determine the general strategic location of the defensive works and the limits of the areas that it was desired to have accurately mapped, prepare strategic plans, and then ask the War Department to send engineer officers, in charge of engineer troops, to the locality to prepare complete working plans on the general lines indicated in the strategic plans.

For the past four years, from one to three hundred men of the Engineer Corps have been at work in the various localities at the request of the board, with the result that at the present time there is in the hands of the board data for the preparation of projects for nearly all of the coast artillery subdistricts within the continental limits of the United States.

Projects for all the more important fortified harbors have been submitted to the War Department and approved by the latter for distribution to the proper custodians, to whom are assigned certain duties in connection with the projects. Superior commanders or special inspectors make periodic inspections of the work that local custodians are required to do, and make report thereon to the War Department, so that at all times the Department is informed as to the condition of preparedness in which the defensive plans are kept in each locality.

At the present time, the problem submitted to the committee of General Staff officers in 1906, namely, "The Protection of Seacoast Forts from Attack by Land," is about ninety per cent completed, in so far as the preparation of *defense projects* is concerned; and the board hopes that within the present year the plans for each coast artillery subdistrict in the United States will have been submitted to the War Department. When this shall have been done, it may be considered that the work for which the board was organized has been completed.

In preparing the defense projects, the members of the board have been given full authority by the War Department, and practically all of its suggestions and calls for assistance have been promptly complied with.

The young engineer officers in charge of designing fortifications and other field work have done their work most loyally and well. District engineer officers and artillery district commanders have collected the best obtainable maps in their localities for the board and have been, without exception, enthusiastic and energetic in doing the share of the work allotted to them. Where completed plans have been placed in the hands of local custodians, the inspections indicate that the work they will be called upon to do in case of war is kept well in hand. All in all, the board feels that, though its work has been long drawn out and though it would like to have finished much sooner, yet a large piece of work is nearing the completion of its first stage, and its earnest recommendation is that the work be kept abreast of the times as changes in other matters demand revision of the projects.



# THE EVOLUTION OF OUR SYSTEM OF POSITION FINDING AND FIRE CONTROL

BY CAPTAIN H. L. MORSE, COAST ARTILLERY CORPS

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The history of the development of the present coast defense system of the United States has not been the subject of any serious investigation until very recently, and the subject of the present paper has not been touched upon, as far as is known to the writer, in any but the most cursory manner, and that in the current series of articles in the JOURNAL OF THE UNITED STATES ARTILLERY of which this constitutes one.<sup>1</sup> It has been necessary, therefore, to search the files of the JOURNAL, the reports of the Board of Ordnance and Fortification, the Artillery Circulars, Notes, and memoranda, numerous manuals and instruction books of various dates and authority, and many reports not included in the above enumeration, in order to accumulate data from which to form the most elementary conception of the subject. Many important links in the chain of development could not be found included even in the wide range of references indicated, so search was made for modifying correspondence, often in vain, and inquiries made of active and retired officers under whose influence and supervision the developments had occurred. The sources enumerated have supplied the facts, dates, and details of apparatus which are included in this paper.

It was, however, appreciated by the writer before the first reference was opened for examination, that an historical sketch of this nature, to have any interest or real historical value, must include, as explanatory of the chronological skeleton of facts and dates, as full an account as practicable of the influences acting at the different stages of development of the system; for no fact is of significance, except in its relation to other facts or incidents, antecedent or consequent, and in the light of knowledge of the circumstances attending it. A history of the changes in the art of position finding, without mention of the defects in systems or apparatus obtaining at the



various stages, or of the needs for improved action which led to the changes, would seem to be without practical value, as well as barren of interest for the reader. Very little of the published matter on the subject, of whatever date, supplies anything of value from the point of view just mentioned; so several of the officers whose names are most prominent in connection with the development of our position finding system have been appealed to to give their recollections of the interplay of influences which preceded the more important steps in advance, as well as of incidents which might be expected to "humanize" the article and enable a reader to draw from the succession of facts deductions more nearly correct and of greater value.

In addition to noting, as above, the sources from which the matter of the paper has been drawn, it may be stated with propriety that the writer has drawn practically nothing from his own experience, he having entered upon his coast artillery service after the system had been evolved. Many errors of omission are, therefore, hardly avoidable, and undoubtedly there are others of deduction or of fact; but it is the writer's hope that the subject is of such interest to the Corps that all errors which he may have made will be corrected through the pages of the JOURNAL, and thus an accurate and full development of the subject result.

The subject might be divided according to the several distinct objects to be accomplished, with the devices evolved for the purposes. The system of communications, for example, an essential part of the complete system, might be considered without reference to the other essentials, classed, for convenience under the headings, (1) Range and position finders, and (2) Computing methods and devices. The principles of fire control and direction, again, might be considered almost without reference to the particular systems or devices considered under the heads just suggested. But such a division as the above would be better suited for a paper purporting to be a mechanical and electrical treatise on devices and apparatus than for a "history" of the evolution of a system, which it is the writer's aim to produce. For the latter purpose a more convenient and natural division is found in the various successive periods, or rather epochs, into which the steps of development may be grouped, even though, because the lines of demarcation between those epochs are not definitely drawn, the classification chosen for the present paper may be open to

adverse criticism. The division is made, however, with the sole aim of a clearer presentation of the subject, and is based on no claims which demand establishment; and since it is not used as an argument in the discussion of the paper to any appreciable extent, it is hoped that critical readers will not subject it to too detailed an examination, but will consider it merely as a means of providing a convenient set of pigeon-holes in which information might be filed, and from which it may be drawn as desired.

While previous to about 1892 many individuals had been working in the position finding field, and valuable results had been accomplished, yet very few knew what anyone else was doing, and, to say the least, there was no concerted action. One post might be found using methods adapted from the latest English practice, with continuous endeavor toward improvement, while another post within sound of its guns would be using the clumsy methods of ten years before, or rather, using no methods at all, as close order infantry drill required no position-finding service. The ambitious ones were hampered by lack of matériel, and the surprising thing is that so many were found to interest themselves in such a hopeless task as the development of efficiency in any portion of the artillery service must have seemed at that time. This, in fact, was a "Period of Solution," ideas showing no signs of crystallization into a system.

The state of the art at any time may to a certain extent be deduced from the current orders and circulars, and several are quoted below which are interesting from this point of view.

Army Regulation 466, of 1881, read as follows: "The flight of a shell may be noted with sufficient accuracy by a stop-watch \* \* \* and the range may sometimes be computed by the time of flight. Other modes of ascertaining the range will readily occur to officers of science."

General Orders No. 108, Headquarters of the Army, Adjutant General's Office, 1888, required at every post "one or more carefully measured base lines, of suitable length," with extremities marked and placed under shelter, and otherwise suitable for angle-measuring instruments. The azimuths of these lines were to be determined. With these base lines were to be used "angle-measuring plane tables" furnished by the Ordnance Department. The system thus made possible was supplementary to the square system, as in the same order we find reference to the Regulations of 1881, Par. 464, which re-

quired harbor charts with soundings, etc., marked thereon, on a scale of 100 yds. = 1 inch, with 1 inch squares. For each gun were required tables showing the "direction and distance" from the gun to each square.

It is interesting to note that this order, a target practice order, laid down the following ranges for the matériel then in service, viz.: For 15-inch and 10-inch S. B. and 8-inch and 4½-inch M. L. guns, 1700 to 2700 yards; for 13-inch and 10-inch S. C. mortars, 2000 to 3000 yds.; for 10-inch and 8-inch siege mortars, 1000 to 1500 yards.

These orders of 1888 assumed the provision of each post with the following list of articles given in Appendix A, Report of the Chief of Ordnance for 1884:

- 2 angle-measuring plane tables,
- 1 transit,
- 2 Pratt range finders,
- 1 100 ft. tape line,
- 2 Auburndale stop-watches,
- 1 Robinson anemometer,
- 1 aneroid barometer,
- 1 hygrometer,

supplied by the Ordnance Department; and

- 3 telegraph keys and sounders,
- 3 Crown telephones and call bells,

furnished by the Signal Corps.

The range finders included in the above list were a field type of instrument, and no further mention of them is found in connection with sea coast artillery fire. The plane tables consisted of a 122° brass arc sunk in a board, graduated to half degrees and numbered at 5° and 10° intervals, with an alidade pivoted at the center.

An instruction order, General Orders No. 49, Headquarters of the Army, Adjutant General's Office, 1889, provided for courses of instruction, in adjustment and use, "at such posts as may be provided with the necessary apparatus;" and from the prominence given "judging distance exercises" in the vessel-tracking drill called for, we may deduce that range finders played no important part in the proposed system.

The earliest report of performances in position finding which the writer has been able to find, occurs in Appendix 13 of the Report of the Chief of Ordnance for 1884. Colonel John Hamilton of the 5th Artillery, reporting on artillery practice at the Narrows, New York Harbor, says, in reference to vessel

tracking: "On one occasion at least sixty consecutive observations were made within thirty minutes, \* \* \* each observation involves the reading and transmission from the auxiliary to the plotting station by telephone of an angle, its plotting on the plane table of the plotting station, recording angles, and noting time and range."

The foregoing quotations seem to indicate a fairly well advanced system of position-finding, at least equal in effectiveness to the system laid down in the "English Garrison Artillery Drill" of 1887, with the essential instruments already in use or foreshadowed, the necessity for the various corrections recognized, and actual plotting of moving targets brought to a creditable degree of facility with the matériel available. It must be insisted upon, however, that the system was almost entirely "on paper"; that the approved matériel of the quoted list was not generally supplied; that the actual vessel-tracking noted was undoubtedly one of only a few isolated instances; that for one officer who interested himself in position or range finding as an art of any perceptible degree of refinement there were probably fifty to whom the very term was unfamiliar. Some improvement in this condition toward the latter end of the period was certain to develop, but that the general condition has been fairly represented may be seen from the following quotations.

Lieutenant Colonel I. N. Lewis, Coast Artillery Corps, in a letter to the writer in regard to the present subject, says, in part:

You younger officers of the Coast Artillery cannot possibly appreciate the obstacles which had to be overcome and the many disappointments and discouragements we met with when the Wadsworth work was first undertaken. As an illustration, I may tell you that when I first reported for duty at Wadsworth in 1892 in connection with my earlier range finder work, there was not an angle measuring instrument at the post; no telephone or electrical instrument of any kind; not even a set of drawing instruments. There was absolutely not a trace of even the beginning of any single element of our present elaborate system of fire control. There was no official appreciation of the need of such instruments or such a system.

Another interesting contribution is the following. It is a printed sheet, without heading or date, but stated to have been in force at David's Island (Fort Slocum) in 1894.

#### INSTRUCTIONS FOR FIRING AT MOVING VESSELS

I. Estimate the distance to the vessel; give the general direction to the piece; and set the sight at the elevation required for the distance.



stations were telephoned to post headquarters. Here the data was plotted by means of circular protractors or the string and azimuth circle combination, under the supervision of the post commander, and the range then telephoned to the guns. The gunner applied all corrections, drew his elevation from tables, etc., etc., and often hit the stationary target at the range then used, about 2000 yards.

Both of the above quotations are dated in years subsequent to the limit I have assumed for the first period, and so may be taken as a conservative indication of the stagnation which characterized that period. Indeed, there was little else to be expected under the prevailing conditions: the Artillery had no Chief, no JOURNAL, and, as a whole, little interest in coast artillery matters. As stated by one of the first contributors to the JOURNAL, Captain James Chester, in No. 3, Vol. 1, (1892), "An artillery garrison is looked upon as an infantry battalion and treated accordingly. Artillery instruction is like a side show at a circus, permitted rather than prescribed."

The year 1892 has been chosen for the beginning of the second period, called the "Period of Crystallization," on account of the birth of the JOURNAL OF THE UNITED STATES ARTILLERY. In the JOURNAL was found the medium for exchange of views among those officers already interested and working, an incentive to interest on the part of the rest of the Artillery personnel; and an educational and publicity organ of the greatest value; and though in other respects there was no noticeable change of conditions, though there was still no matériel, no appropriations, no real head to the Artillery, and little prospect of promotion or active service, nor other incentive to ambition on the part of the officers of the Artillery, yet this means of interchange of ideas, voicing of complaints, and general unification of effort, multiplied many times the effect of the progressive work of individuals as well as the number of individuals actually at work. To what extent, and in what ways the JOURNAL affected the advance in our art cannot be taken up in this paper; but its influence for good was undoubtedly strong in the right direction from its inception, so that from 1892 on we can observe real progress at a rapidly increasing rate, with fewer and fewer backward steps, and the number of officers interested in the professional work of the Artillery increasing every month.

In June, 1892, Whistler's "Graphic Tables of Fire" were published to the service by the War Department as Artillery

Circular "C". These tables were a most important step in advance, and issued at a timely juncture. Ingalls' work had illuminated exterior ballistics to the point where all interested officers recognized the necessity for the exact knowledge of many factors affecting the trajectory which had hitherto been neglected or roughly "guessed at," and the methods of applying these corrections were one of the subjects of discussion in the article, already referred to. The Theoretical Instruction of Gunners," by Captain James Chester, 3rd Artillery, in No. 3, Vol. I, of the JOURNAL. Many serious objections were offered, in the discussion of the article, to any attempt to teach enlisted men ballistic formulas, with a view to their use of them in service or at target practice, and Colonel Whistler, then first lieutenant, 5th Artillery, in his discussion offered his "graphic chart" method of applying the corrections as a substitute. It seems to have been enthusiastically received, and constituted, in our service at least, the first step toward the range board which is now an essential part of our system, foreshadowing the use of correction curves applicable at any range for a specified gun, though not utilizing any mechanical device for taking out the corrections.

In respect to position finders, the Board of Ordnance and Fortification, established in 1888, had been working to some good effect; so that its first report, including operations from its inception to October 30, 1891, gives about two hundred words to a consideration of the necessity of some "optical or mechanical devices for determining the location of a distant object" owing to increased range of guns and increased cost of ammunition. The principle of all is recognized to be the solution of a horizontal or a vertical triangle, and the plotting board is suggested in the method noted of "converging radial arms moving over a map of the harbor approaches."

The remaining half of the discussion of range finders notes the purchase of the following types for test, viz., Fiske, Ruckman-Crosby, Berdan, and Lewis; reports the test, by the newly appointed Range Finder Board of all but the Lewis; and reports the preparation of the Lewis instrument for test at Fort Wadsworth. It may be noted here that, for some reason, the second (October, 1892) report of the Board of Ordnance and Fortification makes no mention whatsoever of the subject of range and position finding.

Whistler's "Graphic Tables of Fire" had been based in part on actual ballistic firing, and in June 1892 further ballistic



firings were instituted at Fort Monroe by Captain Mills, instructor in practical exercises at the school, for the purpose of determining the initial velocity to be expected from certain powders to be used in the approaching target practice season, and to verify certain of Whistler's curves. The subject of the firings as a whole is not germane to the matter of this paper, but the following extract from the report of the firings is of interest as recording the birth of the wind vane in practically the same form as we now use it: "For this practice it was considered necessary to obtain a greater degree of accuracy, in determining the direction of the wind, than could be obtained by holding up a handkerchief or a wet finger near the gun." Lieutenant Parkhurst, 4th Artillery, therefore devised "a simple wind vane for temporary use." The vane itself was flat, instead of cylindrical, as in the present vane, but in all other respects the device was essentially of the form now standard. A more elaborate wind indicator, arranged to be centrally located and to be read from a distance from any direction, was in use at Fort Wadsworth at or before this time, and the idea of several officers who were most active in fire control development was that all meteorological data should be automatically displayed on large dials or diagrams at the same central station, visible from all battery stations of the post, the desire being to do away with communications between the meteorological station and the batteries. The simpler form has naturally survived on account of the wide extension and reliability of the system of communications.

The next notable step is the issue, with date January 19, 1893, of Artillery Circular "E", "Course of Instruction for Artillery Gunners, Range and Position Finding," by First Lieutenant Henry L. Harris, First Artillery, prepared for publication under the direction of General Schofield, then commanding the Army, by his aide-de-camp, Captain Tasker H. Bliss. In this pamphlet the subject of range and position finding is set forth at length, definitions given, and several foreign instruments described and their use discussed. The authority for the system then in use was still General Orders No. 108 of 1888, and for the harbor charts, paragraph 464 of the regulations of 1881. Range and position finding systems as defined stopped with the determination of the actual range or position, and by implication threw on the gunner the application of all ballistic corrections. The system as described consisted of azimuth circles at each end of a base-line represented to scale on a plot-



ting board. On the board was plotted also the position of the gun or guns. The position of the target was found by intersection, and the range from the gun was measured by applying a scale. "The gunner, after consulting his range table and the atmospheric and anemometer indications, lays his gun on the target." Either threads, with graduated azimuth circles, or circular protractors were contemplated for use on the plotting board, which was separated from the observing stations and in telephonic communication therewith. One of the plates which supplement the text indicates that true azimuths were used, displacing the original plane table angles, which may or may not have been borrowed from the English service, in which this method of orientation (exactly as now employed in our service), had been in use for some time.

In discussing range finders suitable for seacoast artillery, mention is made of the Watkins (English), the Deport (French—more an automatic sight than a depression range finder), and the Fiske (United States); and it is remarked that "Lieutenant Lewis of the artillery has invented a depression position finder which is now in course of construction." The Watkins, the Deport, and the Fiske instruments are very fully described, with the methods of applying corrections for tide, "normal refraction," and curvature. Datum points with a tide reference mark are called for, and the electrical illumination of the cross wires of observing telescopes is noted as an essential feature thereof.

Communications are dismissed with but brief mention. However, the necessity for means of prompt communication as a part of any horizontal base system is clearly recognized; flag signalling is discarded as a possibility on account of its slowness, and it is stated that "the telephone, if in good working order, will answer every purpose of drill." Automatic indicators of range and deflection or azimuth at the guns, following the movement of the position finders, are mentioned as a desirable possibility. That feature is credited to the Watkins D. P. F., but the manner in which the function is performed is stated to be unknown.

Plotting of position is accomplished as noted in the preceding paragraph, gun range being measured by scale; but a "converter board" shown in a plate and briefly described, shows a method of relocating by means of a gun arm with its own azimuth circle, mounted on a board with the arm and azimuth circle of (presumably) a D. P. F. station. This gun arm,

of course, carries no correction devices for either range or azimuth. A thirty second observing interval is contemplated.

The matter which I have briefed in the preceding paragraphs takes up nearly the entire pamphlet, and it may thus be seen that the publication is rather a general treatise on the subject of position finding than a manual for use in drill or target practice. None of the instruments mentioned as suitable for sea-coast artillery work had as yet been supplied to the artillery. The Pratt range finder, listed for supply to posts in General Order No. 108 of 1888, referred to, is described in the pamphlet, together with the Le Boulengé telemeter and the Weldon range finder, but none of them is included in the list of those suitable for seacoast work. The pamphlet itself indicates how little general was the supply of equipment by saying, "*Several of the more important posts* [the italics are the writer's] have been supplied with azimuth circles reading to minutes, plotting boards, range scales forty inches long, graduated to read five yards, circular protractors, reading to minutes, and with extension arms, rubber triangles, T-squares, drawing instruments, etc." The only matter approximating the definite style of a manual is about a page of suggestions as to a method of conducting a vessel tracking drill, observing, plotting, etc., synchronizing observations at the two base ends by "Ready" — "Now," called through the telephone, setting the threads for plotting, and relocating by scale, etc., every thirty seconds, with a further suggestion that the time may be reduced to fifteen seconds with experienced personnel.

Depression position finders as distinct from range finders, are dismissed with the remark, "Of vertical base, or depression position finders, very little can be said, as very little has been ascertained about them by the writer." He suggests, however, that a good depression range finder needs only the addition of an azimuth circle to make it a position finder.

The pamphlet is, therefore, an exceedingly good record of the "state of the art" in 1893. No command larger than the battery is discussed or mentioned. Transition from the square to the polar coordinate system of identification is suggested in the following quotation: "It will be observed that the square system, the system authorized for the United States service, is a system of polar coordinates restricted to the square centers.

\* \* \* \* \* Should the Department authorize the extension of this system of polar coordinates, so that it would apply to every point on the water level within the field

of fire instead of being restricted to the square centers, etc., etc.” When indication and identification of targets began to be a question of importance and discussion, the above quotation might well have been taken as a starting point in the development of methods. And the same remark applies to the subject of position finding proper also, all of the details of which are touched upon in the pamphlet with such exact understanding that the essential principles outlined have suffered no change to the present date. The application of corrections in the plotting room rather than by the gunner, which has come to be included in the term “System of Position Finding,” was then considered as a separate problem.

The publication to the service in circular “E” of such a full and accurate statement of the position finding problem, illuminated by discussions of the most noteworthy attempts at solution, must have had a far-reaching influence in the development of the art; and to-day, as an historical record, the circular is still of great importance and value.

A very remarkable and important article appeared in the JOURNAL, Nos. 3 and 4, Vol. 2 (1893), entitled “Artillery Difficulties in the Next War,” by Lieutenant J. W. Ruckman, then editor of the JOURNAL. This was a paper which had been read to the officers at Fort Monroe in June, 1892, and is notable in that it presents the artillery problem in detail in practically the same fullness as we see it now, and not only that, but offers solutions and predicts developments which are now facts or still the desired ends toward which we are earnestly striving. An exhaustive treatise on modern seacoast artillery could have no better text than this article, and the writer regrets that he must confine himself to quotations which treat of the subject matter of this paper, the whole article being so interesting and pertinent to the conditions of to-day.

Among the first efforts at position finding may be named the “method of squares.” It forms in the historical development a connecting link between the old, where accurate ranges were thought to be useless refinements, and the new, where the range is considered essential. The harbor was divided into a large number of squares whose centers were located by their distances and azimuths from the gun. The object had to be located by triangulation and the number of the square whose center was nearest, was sent to the gun. The distance and azimuth of the center were found from prepared tables and the gun laid accordingly. \* \* \* This method was adopted for our coast artillery in General Orders No. 108, Headquarters of the Army, Adjutant General’s Office, 1888. The side of a square was prescribed as 100 yards. The distances and azimuths of all squares within a radius of three

miles were to be computed and tabulated. The tables when made out were enormous and impracticable. The polar coordinates thus tabulated gave data for points varying from 100 to 140 yards apart depending on the direction in which the object was moving. It is also evident that any given observation would on arriving at the gun be always several squares behind the ship's true place. By decreasing the size of the squares the tables become more cumbersome but the tabulated results when applied should be more accurate. Finally at the limit, the ship's path would be made up of points whose distances and direction would be known. *This is the result which will be obtained by the coming position finder which, without any cumbersome tables, or any other of the numerous objections to the squares, will trace upon a map the path of a hostile vessel.* [The italics are the writer's.]

A battery, we believe, should always concentrate its fire on a particular object. Groups of batteries in like manner should concentrate on a prescribed vessel or vessels. Finally, such communication must exist between the central station and all batteries that the commanding officer can quickly and simultaneously direct all or any portion of his guns upon a given point or object.

A method of transmitting orders in a fort seems to have been ignored in our works. A more necessary portion of a well-equipped place could scarcely be omitted. While a system of transmitting orders may not, in the past, have been necessary, all may depend on an efficient system in future.

The future range and position finder will trace the path of a vessel continuously upon the map of the harbor. Unless placed at the gun-battery, the plotting apparatus must operate in connection with another device for sending range and direction to this point.

It is difficult to overestimate the worth as respects the development of the art of coast defense of as clear-viewed an exposition of the problems presented as the article from which the above quotations are taken, and though many other officers must have had as definite views as are expressed by Lieutenant Ruckman, yet the reading at Fort Monroe and subsequent publication in the JOURNAL must have allowed his views a well-deserved and wide-spread field of influence.

Before proceeding further with the discussion of the train of development and its current records, it may be well to touch briefly on the subject of the personnel which was responsible for progress. At the head of the Army and of the Board of Ordnance and Fortification until his retirement in 1894 was Major-General Schofield, in both capacities always deeply interested in the Artillery and instrumental in its development. The first effort subsequent to the Civil War to initiate general instruction of the artillery troops in target practice with sea-coast guns was made by him about 1886, when in command of the Division of the Atlantic. With him and equally interested in the Artillery were General J. P. Sanger, then major and inspector general, and General Tasker H. Bliss, then captain

and aide-de-camp, the latter of whom prepared for publication Harris' "Range and Position Finding," issued in 1893, previously referred to. The members of the Board of Ordnance and Fortification, beside General Schofield, who were more particularly interested in the position finding developments, were Colonel Henry L. Abbot, Corps of Engineers, Colonel Henry W. Closson, 4th Artillery, and Major Clifton Comly, Ordnance Department, to all of whom the Artillery owes more than the debt normally due for duties well performed, as their understanding of the needs of our arm was particularly clear, and their endeavors for the betterment of its condition notably persistent and helpful. To the efforts of the last two is largely due the establishment in 1894 of the Board on the Regulation of Seacoast Artillery Fire, which will be frequently referred to later on. The Range Finder Board, first referred to in the Report of the Board of Ordnance and Fortification of 1892, was appointed by Special Orders Nos. 249 and 258, Headquarters of the Army, Adjutant General's Office, series of 1890, with the following personnel: Lieutenant Colonel A. C. M. Pennington, 4th Artillery, Major M. P. Miller, 5th Artillery, Captain D. M. Taylor, Ordnance Department, Captain J. G. D. Knight, Corps of Engineers, and First Lieutenant Edw. Davis, 3rd Artillery, recorder. On May 5th, 1894, First Lieutenant H. L. Harris, 1st Artillery, was assigned to duty with the Board as executive officer. In 1896 Captain F. E. Hobbs replaced Captain Taylor as representative of the Ordnance Department. Otherwise the Board had a permanent constitution until its duties were, in 1897, turned over to the Board on Regulation of Seacoast Artillery Fire. As this latter board did not begin its official labors until the end of 1894, consideration of its personnel will be left until later on.

Another influential group of progressive officers was the Committee of Publication of the JOURNAL OF THE U. S. ARTILLERY, which was composed, for the first year, 1892, of First Lieutenant W. B. Homer, 5th Artillery, First Lieutenant H. C. Davis, 3rd Artillery, First Lieutenant J. W. Ruckman, 1st Artillery, First Lieutenant C. DeW. Willcox, 2nd Artillery, and Second Lieutenant L. G. Berry, 4th Artillery; and for the next two years, 1893 and 1894, of Colonel Henry W. Closson, 4th Artillery, Captain James M. Ingalls, 1st Artillery, Captain Edmund L. Zalinski, 5th Artillery, Lieutenant Erasmus M. Weaver, 2nd Artillery, and Lieutenant George O. Squier, 3rd

Artillery, with Lieutenant John W. Ruckman, 1st Artillery, as editor.

Lieutenant I. N. Lewis had been working on the position-finding problem since some time in 1888, and Lieutenant Rafferty and a few other officers, who will be mentioned later on, had been working on one or another phase of the problem for longer or shorter periods.

As previously mentioned, no progress in range and position finding was noted in the Report of the Board of Ordnance and Fortification of 1892. The Range Finder Board was studying the problem, testing the various instruments available, and reporting defects to the inventors of the instruments for correction. The Fiske range and position finder, an instrument using a horizontal base of about 277 yards, in which the horizontal triangle is solved electrically, utilizing the principle of the Wheatstone bridge, and the Lewis depression position finder, of well known principle, were purchased for thorough test in 1893, while a third form, by Zalinski, was noted as about to be tested, and to be purchased if satisfactory. A large number of field range finders were also ordered purchased for test in the same year. Allotments of funds were made for providing telephonic communication between Forts Wadsworth and Hamilton, for moving the Lewis D. P. F. under test, and for completion of an accurate map of New York Harbor, all for the purposes of the Range Finder Board.

In connection with the system of communications note should be made of the allotment for purchase of three Greely ink-writing registers. The telephones commercially used at this time were not suited to the uses of the artillery, their construction being such as to make them unreliable; and a strong sentiment in favor of a permanent record of orders and data transmitted, encouraged the officers responsible to look for a solution of the communications problem in the direction of some writing or printing instrument, such as the Greely, or, later, the Gray, telautograph. Among the suggestions offered in No. 2, Vol. 3 (1894), of the JOURNAL, General Weaver (then lieutenant, 2nd Artillery) says:

The chief defect in the system is the delay attending the transmission of angles. There should be electrical connection between the plotting house and the observing station \* \* \* a simple connection of each observing station with an ordinary hotel annunciator, at the plotting board, running up to 60 for minutes and another division running up to 180 for degrees would enable the observers to transmit angles by merely pressing the proper buttons.



A further valuable comment and suggestion is found in the same article under the heading "Tactical Firing," in which Lieutenant Weaver called attention to the weakness of the existing system in that it was valueless, or nearly so, for firing at targets in motion, which would be practically the only case met with in actual warfare. He says:

It seems to the writer that the one point we have most flagrantly neglected is *practice at moving targets*. \* \* \* I have never seen the attempt made in regular practice to fire at a moving target in the eighteen years of my service in the artillery, except once at Fort Monroe. In the summer of 1887 Captain S. M. Mills, 5th Artillery, then in charge of target practice, had a target towed across the field of fire and it was fired at from a 15-inch S. B. gun. \* \* \* The difficulties connected with the practical problem of causing the projectile and target to meet at a guessed-at point ahead, were, I think, a revelation to most of those who were called upon to fire the gun.

He goes on to say that, realizing the importance of the problem, and being requested to contribute suggestions on Coast Artillery Fire Instruction to the JOURNAL, he asked for and obtained authority to fire ten rounds from the 8-inch rifle at his post, Fort Adams, R. I., to test a system of firing at moving targets which he had devised as a solution of the problem, which presented itself to him as follows: "A ship is at a point (A) in the field of fire, moving in a direction (X-Y), at rate of (K) knots per hour. Required: to hit the ship. "(A)," "(X-Y)" and "(K)" were given two minutes before the projectile was required to be at its destination." Excellent results were obtained in the firings, but unfortunately the methods and devices employed are not described in the article. In No. 4 of the same Volume of the JOURNAL, referring again to the 1887 firing at Fort Monroe, Lieutenant Weaver said: "There were two points I wished to emphasize in referring to this incident. First, that there was one officer who as far back as 1887, had appreciated the importance of fire at moving targets; and, so far as my knowledge goes, Captain Mills is the only officer who has made a practical effort to do anything in this field."

During 1894 the Range Finder Board conducted tests on the Lewis and the Watkins depression range finders and the Fiske horizontal base electrical instrument. The Watkins gave only fair results, the Fiske promised well, and the Lewis appeared to be entirely satisfactory; but no final report was made, as the Zalinski instrument was expected but had not yet been submitted to the board. The Board of Ordnance and Fortifica-

tion was so encouraged by the progress report of the Range Finder Board that, noting that the Range Finder Board was authorized only to test these instruments, it recommended as follows in its annual report of date October 31, 1894:

It is therefore recommended that a board of three artillery officers be appointed, to be designated "the Board on the Regulation of Seacoast Artillery Fire," to be selected preferably from those who have evidenced the greatest interest in this subject, and who are or can be stationed in the vicinity of New York, to develop and recommend a practical system of utilizing seacoast range finders and directing the fire of the fortifications at the Narrows against an attacking fleet.

In prefacing the above recommendation the Board said:

It is desirable that a complete system should be devised and settled upon by means of which any battery or any gun in the defenses can be quickly and accurately trained upon an advancing vessel. Several important questions must be determined: the number of instruments that will be required; the most advantageous position for them; the means of communicating with the guns; the method of converting the data given by the range finder into data utilizable at the gun, which may be many hundred yards distant, etc. The Board proposes New York Harbor as the proper place to inaugurate a typical system of this kind.

A "new and ingenious plotting device" invented by Lieutenant Weaver, "for directing the fire of batteries at moving targets," had been submitted to the Board of Ordnance and Fortification during the year and subjected to a series of practical tests at Fort Monroe, and the results of the tests had been so favorable that the device was referred for further test to the newly constituted Board on Regulation of Seacoast Artillery Fire, together with the Rafferty relocater, just purchased for test.

The new board was constituted by Special Orders No. 273 Headquarters of the Army, Adjutant General's Office, November 20, 1894, and was composed of Lieutenant Henry L. Harris, First Artillery, Lieutenant W. C. Rafferty, First Artillery, and Lieutenant I. N. Lewis, Second Artillery. The personnel remained unchanged for the ensuing two years, during all of which time Lieutenant Harris was serving also as executive officer of the Range Finder Board, so that the work of the two boards was effectively coordinated until their duties were merged and assigned to the Board on Regulation of Seacoast Artillery Fire in 1897.

While the official boards and many individuals were working on improvements to the system, no less valuable work was being done at various posts and at the Artillery School in en-



deavoring to get the best results from the matériel issued, and in improving it to meet the needs of the service. In Vol. 4 (1895) of the JOURNAL Lieutenant Parkhurst commented on the desirability of standard verniers for the circular protractors in use on the plotting boards, and the necessity of an improved method of attaching them to the boards and adjusting the centers to the ends of the base line and gun centers. Lieutenant Lassiter, First Artillery, in an article on range and position finding in the April JOURNAL of the same year, voiced a wholly new attitude of mind toward the subject of the artillery art which had begun to develop, as follows:

After all, while waiting for something better, it is in our power to obtain very good results from the simple and unpretentious position finding apparatus at present in our hands. We have at the Artillery School with comparative ease plotted the positions of a moving target at intervals of twenty seconds.

But no provision at all has been made for the time when all the batteries of a garrison are to be in action at once,—when they are all to be informed of the range and the situation of their respective targets, when the commanding officer is to assume general control and direct the fire of the units under his command in the most advantageous way: in other words, for the time when all the component parts of the defense should be able to co-operate to inflict the greatest amount of injury upon the vessels of the hostile fleet.

As for the employment of the position finder in connection with a coast defense system, developed on the lines of fire control, it would seem that a position finder should be provided for the district commander, one for each of the fire commanders, and one for each group commander.

The district commander, then, by the use of his position finder and a chart showing the zones of fire of the various forts, \* \* \* judges when fire should be opened, and by what forts or groups of guns, and then gives his directions to the fire commander. The fire commander by use of his position finder and some such chart as that referred to by Lieut. Zinn in his contribution to the JOURNAL for April, 1894, (a harbor chart marked in squares, the azimuth and range to the center of each being computed and tabulated), locates the position of the vessel or vessels assigned him, sees what guns and groups of guns can fire upon it, and indicates the objectives,—a vessel or a particular portion of a vessel,—to his group commanders. The group commander has his position finder turned upon the vessel assigned to him, and kept there until some new objective is indicated. He has already had his staff work out the corrections to be applied for existing conditions or *reads them off directly from some suitable calculating mechanism. It should be possible to "set" the indicating device, so that these corrections would be at once applied to the range and training sent to the guns: this "setting" could then be changed from time to time, so as to bring the mean trajectory of the gun upon the target. We might account in this way for all the corrections necessary to be made on account of powder, wind, drift, hygrometric and barometric conditions.* \* \*

*If again, by the construction of our indicating device, we are enabled after a consideration of the duration of the time of flight and the changes shown on the*

*dials in range and azimuth during that time, to "set" our indicators ahead or behind by the proper amount, we could always keep the guns so aimed with respect to the vessel as to allow for its changing position.*" [The italics are the writer's.]

It is interesting to note how accurately and completely Lieutenant Lassiter described the necessities of a modern position finding system in the last two paragraphs. On account of a knowledge of the English practice (the Watkins system), probably, he contemplates applying all corrections on the indicating device which, connected to the position finder, keeps the range and deflection continually posted at the guns in that system. If we read "plotting system" for "indicating device" in the above, it is seen to be an accurate general description of the system now in use; and a system now under consideration applies corrections on the indicating device exactly as he proposed.

Lieutenant Lassiter's article is notable also in that it outlines a system of *fire control*, as distinct from *fire direction*, to which latter end all previous investigations and writings seem to have been directed. It was, in fact, only just before this time, some time in 1894, that the two terms were first introduced into our service by Lieutenant Lewis and others, they having borrowed them from the English practice.

In this same volume (Vol. 4) of the JOURNAL appeared a description of the Fort Monroe tests of the "new and ingenious plotting device for directing the fire of batteries at moving targets" invented by Lieutenant Weaver, which has been previously referred to and will be described in full in connection with the report of 1896 of the Board on Regulation of Seacoast Artillery Fire.

In connection with the subject of communications we must note the report by Lieutenant Carbaugh, 5th Artillery, of tests of the "Essick Page Printing Telegraph" in No. 4, Vol. 4 (1895), of the JOURNAL. The instrument printed thirty-six characters at a distance, using only two connecting wires. The transmitter, in the form of a typewriter, sent, for any particular character, a definite number of impulses, each in reverse direction to the preceding one. These impulses, at the receiver, by means of a polarized escapement, released an escapement wheel on the same shaft as a type drum, allowing a clock work to turn the type drum to the proper character, when a small hammer struck the paper against the type. The carriage is moved and the paper shifted by the clockwork, magnetically

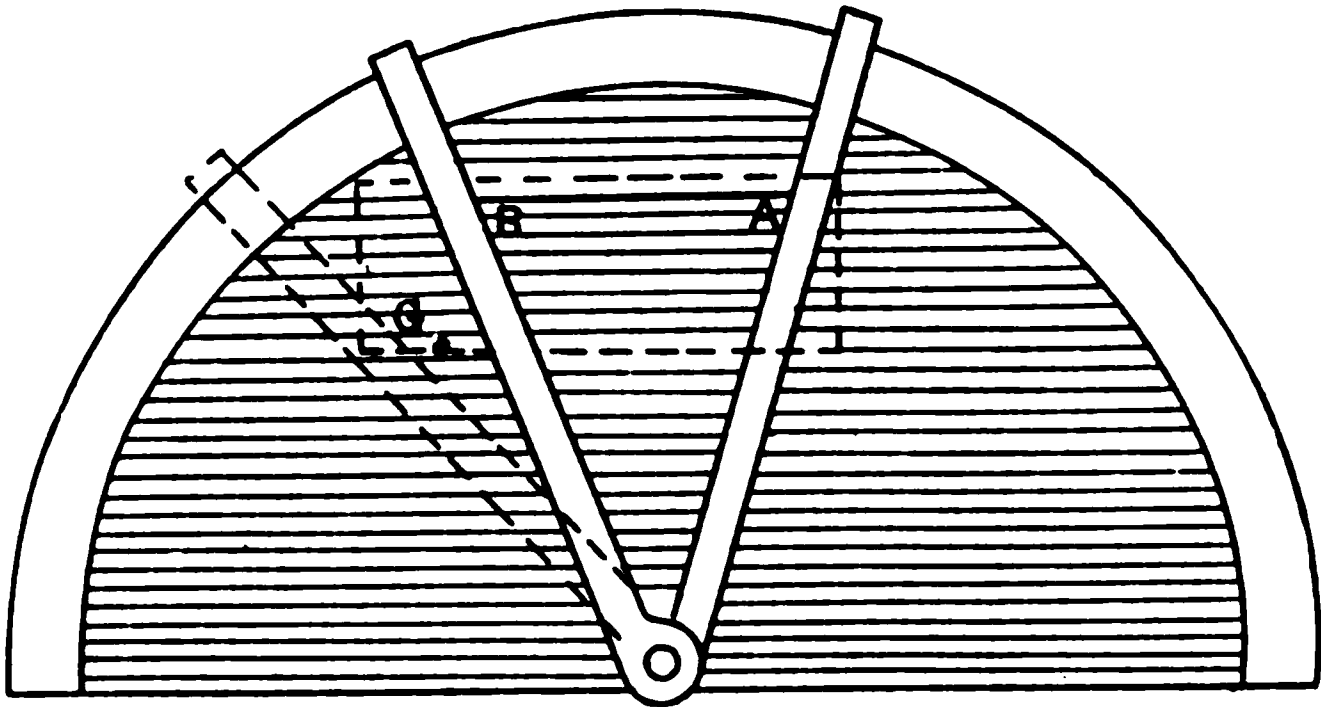
released and controlled. Though the instrument gave remarkably satisfactory results according to the standards then prevailing, it seems never to have been seriously considered for adoption. It would undoubtedly, in its original form, fail of satisfying the reliability tests to which such instruments are now subjected.

Among the "Subjects Considered" by the Board of Ordnance and Fortification during 1895 are eight different types of range finders. Of these a new Fiske and a modified Lewis were recommended to be purchased, further development of the Ruckman-Crosby was provided for, two others were held up "awaiting further information," and only three were "not recommended" in the report. Among the last three is to be noted the camera obscura range finder of Lieutenant Parkhurst, where the basic principle is notably different from that on which the rest were constructed. Lieutenant Millar received an allotment for the construction of his "converter board", and a similar board invented by Lieutenant C. L. Best is noted as before the Board and "awaiting further information." In the field of communications is to be noted provision for a test of the printing telegraph system manufactured by the Consolidated Telegraph and News Company.

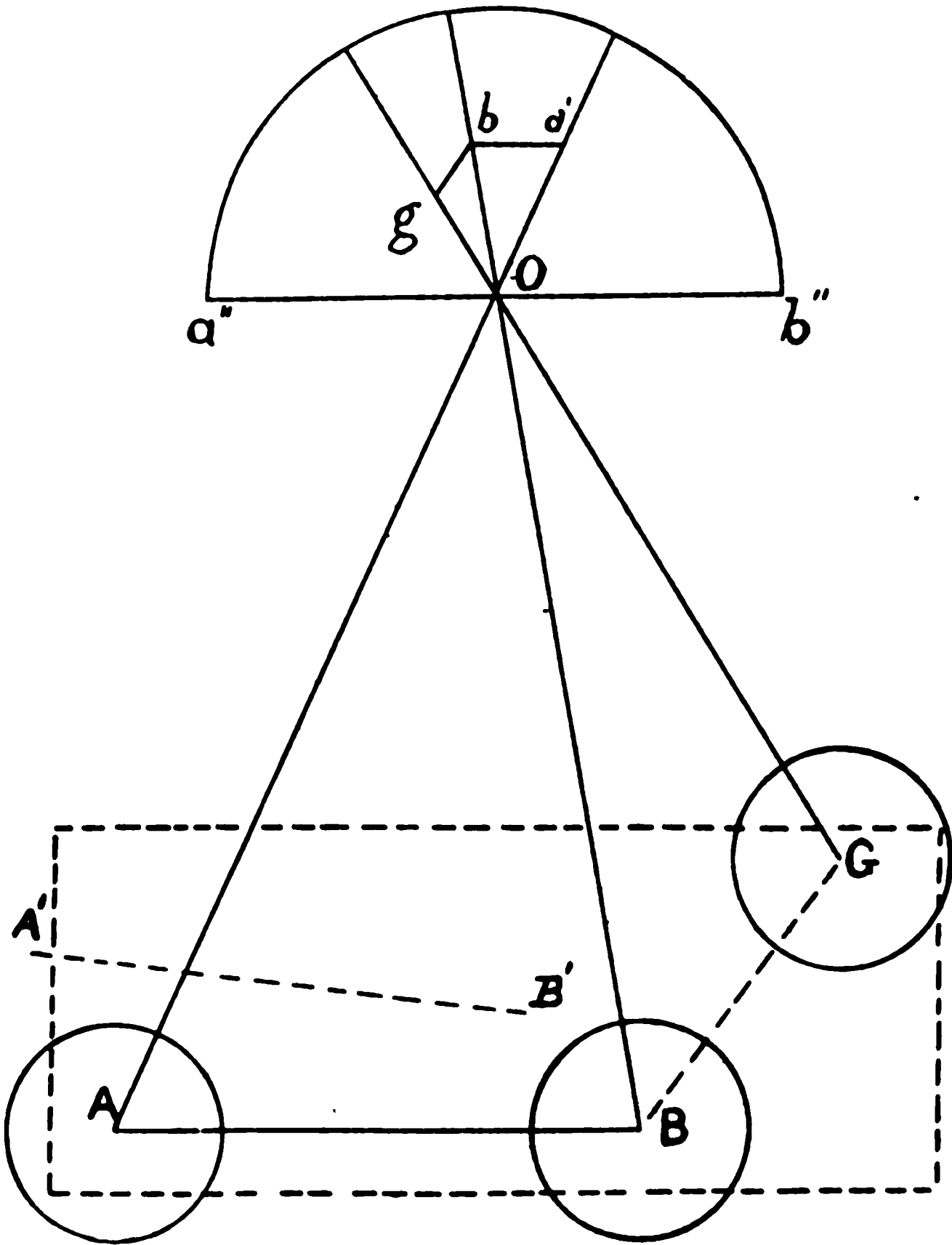
The Range Finder Board had made sufficiently exhaustive tests on the range finders available to be able, in a progress report of July 30, 1895, to recommend as follows:

It was further resolved, That in the opinion of this board the Lewis range finder, for vertical bases between 30 and 100 feet in length, is well adapted to service; that equal accuracy of results and adaptability to service conditions are to be expected from the two other types of the Lewis range finder for vertical bases between 100 and 200 feet, and 200 and 400 feet in length. Therefore the time seems opportune to report to the Board of Ordnance and Fortification that no reason is known why instruments of these two types should not be constructed.

It was also recommended that, the tests of these instruments having been concluded, the Lewis and the Fiske instruments be placed under the control of the Board on the Regulation of Seacoast Artillery Fire. Of other instruments tested, the reports of the Board seem to indicate that development of the Ruckman-Crosby had been abandoned by its inventors some time in 1891, that the Watkins was fairly accurate up to about 4000 yards, and that the Fiske, though amply accurate to within one per cent of the range, was yet slow in comparison with the Lewis, it requiring two operators at the main station,



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making three in all, to complete observations and their records in thirty seconds or less.

The report of the Board on Regulation of Seacoast Artillery Fire is a progress report only, without recommendations. It gives a statement of the material with which the Board were to work, its condition, and the proposed arrangements. It does speak of tests of the Rafferty relocater, with results which were highly satisfactory, and it may be well to describe briefly here this instrument, with which many of the younger officers of the Corps are not familiar, and in which the range-finding triangle is developed from a fixed apex representing the target, instead of from the fixed base line as in the Whistler-Hearn board. Briefly, it is a semicircular board with azimuth circle, similar to the Whistler-Hearn Board, but with only *one* center, which represents the position of the *target* at all times. There is an arm for each station and for the guns served by the board. (In the descriptions of the board only two arms in all are contemplated, one of the station arms serving for the gun also when a horizontal base is used.) Azimuths are set or measured as back-azimuths on the board, the base line being carried on a freely movable metallic spacer which is oriented in azimuth by maintaining it always parallel to the parallel lines with which the board is covered, these being parallel to the diameter of the board (the position of our present base-line arm). The gun position is carried on the spacer together with the two base ends, if horizontal base is used; or, with a single D. P. F., the spacer is of a length representing to scale the displacement of the gun. The operation of the board is as follows, assuming a vertical base: The D. P. F. arm is set to the proper azimuth reading; the displacement spacer is moved up to the arm, touching it at the observed range, and parallel to the lines ruled on the board; the gun arm is moved up to touch the other end of the spacer; then the gun range is read from the gun arm scale where the spacer touches it, and the gun azimuth from the azimuth circle. Assuming a horizontal base: The base end azimuths are set on the respective arms; the spacer is moved up to touch both, being maintained parallel to the lines ruled on the board; the spacer being held in position, the arms are withdrawn, a pin inserted in the spacer at a place corresponding to the gun position, and one of the arms moved up to touch this pin; from this arm the gun range and azimuth are read. The above brief description of the working of the board has been introduced to suggest the possibility of development of a plotting board

along lines different from those followed in the Whistler-Hearn type. It may be seen that a thoroughly practical plotting board might be built up from the Rafferty relocater principle which would entirely satisfy our present needs.

In competition with the relocater is noted the Millar converter board, which was, however, not as yet ready for tests. Other devices submitted to the board include a "deviation index" by Lieutenant Rafferty, for determining wind and atmosphere allowances. In connection with the subject of communications, the initial correspondence with the Gray Telautograph Company is referred to.

Lieutenant H. C. Davis, in No. 4, Vol. 4 (1895), of the *JOURNAL*, and Lieutenant Albert Todd, in No. 1, Vol. 5 (1896), in two steps brought the wind component indicator up to the form in which we now use it, excepting only the reference number principle. Lieutenant Davis proposed first to substitute for the old clock dial of the wind vane, which had to be supplemented by a table of sines and cosines, a dial ruled into squares one-tenth of the radius on a side. The dial was fitted to be turned so that its main axes would lie parallel and perpendicular respectively to the line of fire of a battery, and the wind vane pointer would then intersect the circumference of the dial at rectangular coordinates numerically equal, respectively, to the sine and cosine of the angle between the wind and the line of fire. The ruled lines made it possible to read these values quickly, which were then mentally multiplied into the known value of the wind in miles per hour to give the two components of the wind, deviating and accelerating. Lieutenant Todd further improved the device by ruling the disc into squares one thirtieth of the radius on a side, the maximum wind to be expected being assumed at thirty miles per hour, and graduating the wind pointer into thirty divisions representing miles per hour speed of wind, and each equal to a side of a square on the dial. It will be seen that this is in principle and operation exactly our present wind component indicator, except that the dial was numbered from zero at the center along all four main radii, and its indications had therefore to be characterized as "Retarding," "Left," "Accelerating," "Right" or by means of the clock notation, whereas the reference number principle has effected a further simplification of use in the present form.

The Range Finder Board noted no work along new lines during 1896, but the progress of development of the various instruments before it was noted as satisfactory. The report

of this board is authority for crediting the Board on Regulation of Seacoast Artillery Fire with the first use of the time-interval clock, the Hamilton and Wadsworth stations used in the range finder tests having been connected by the latter board "by telephone, and also by an electric clock and bell system, whereby simultaneous observations at twenty second interval, or any other desired interval, may be made of record." No horizontal base range finder had as yet been recommended, the Fiske, the Ruckman-Crosby, and the Gaillard instruments being still under consideration by the Board. "The efforts of the inventors lie in the direction of simplifying the means of communication between the ends of the base line or automatically indicating the intersection of the lines of sight of the two telescopes upon a plotting board." The Lewis instrument is recommended for adoption as the type of range finder having a vertical base, and this recommendation was approved by the Secretary of War on February 8, 1896.

The Board of Ordnance and Fortification, at its meeting of June 1896, received and approved a report of the Board on the Regulation of Seacoast Artillery Fire on a system of fire control for the United States service, and recommended in connection therewith that a system of regulations and tactics based thereon be prepared and published to the Army. The report just mentioned is one of the most important mile-stones in the progress of development, and deserves extended consideration. Among the new devices reported on by the Board may be mentioned the replotting arm for attachment to the Lewis D. P. F., submitted by Lieutenant Lewis; a visual range and azimuth indicator, submitted by Lieutenant Arthur Murray, since chief of Artillery; a dial telegraph (mechanical transmission), by Lieutenant Lewis; an electrical data-transmitting device, by Lieutenant S. E. Allen; and the Millar converter board, which was tested in competition with the Rafferty relocator, both proving satisfactory and efficient, but the Millar device more expensive and complicated in construction and operation.

Returning to the consideration of the report on a system of fire control for the United States seacoast artillery service, we should consider first the system devised by Lieutenant Weaver which he submitted to the Board of Ordnance and Fortification in 1894, and which was tested out at Fort Monroe by actual firings in the same year in September and early October. No. 2, Vol. 4 (1895), of the JOURNAL contains a full



LIEUTENANT WEAVER'S SYSTEM (1894)

Range dial

1894



6

LIEUTENANT WEAVER'S SYSTEM (1894)

1247

- Fig. 1. Chart of water area showing range zones and azimuth sectors  
Fig. 2. Traverse circle of the gun

description of the system and its workings, and the October number of the same year has a discussion of the system which brings out its weak and strong points more clearly. In brief, it may be said to be a combination of the established "square system" of harbor charts and a transparent ruler and arc for each battery or gun group. The arc is described on the chart with the gun pivot as a center and a radius equal to the maximum range of the gun, and is divided into lengths equal to the length of a battleship, one hundred yards. The ruler is divided along its edge into zone spaces decreasing in width outward, equal at any range to the danger space at that range. Range zones are lettered from the guns outward, and arc spaces numbered from right to left on the chart, so that a ship anywhere in the field of fire of the battery or gun group may be located accurately within the dimensions of one of the gun blocks (in a part of a range zone limited by two adjacent radii) by means of a letter and a number, as B-18. The traverse arc of the gun is graduated by lines limiting angular spaces equal to the angles of the divisions of the arc, and similarly numbered in a counterclockwise direction, while a range dial on the gun is graduated by lines marking the elevations necessary to give the ranges corresponding to the scale divisions on the transparent ruler, the spaces being lettered to correspond to the range zones. Thus a target indicated to the battery or gun group as "in B-18" may, if stationary, be fired on by setting the gun traverse at "18" and the elevation dial at "B"; or, if moving, may be plotted, and its arrival in, say, B-18, after a certain interval, predicted, the guns being set at B-18 by their scales and fired the proper number of seconds (time of flight) before the expiration of the predicting interval.

The above system was referred to the Board on Regulation of Seacoast Artillery Fire for report, and returned to the Board of Ordnance and Fortification on April 20, 1896, with the conclusion "that Lieutenant Weaver's system as here outlined and proposed is too slow and too complex to meet the present or prospective needs of our seacoast artillery service." This remark is intimately connected with the reasoning and conclusions as to the recommended system, submitted in the following month, as is evidenced in the following paragraph quoted from the report submitted at that time:

In a previous report (on Lieutenant Weaver's system), dated April 20, 1896, we made this statement: [There are] "two underlying general principles, one of which must necessarily govern in whatever method of fire control

is to be adopted for our service, viz: First, the system of 'squares,' where the water area to be defended is mapped and plotted into squares or other small areas, each lettered and numbered and the whole tabulated, and second, the more general principle of 'polar coordinates,' where no such mapping and tabulation is necessary."

We believe that the second or more general principle of "polar coordinates" should be adopted as the basis of our system.

Incidentally it may be remarked here, that the "square" system, so often spoken of as distinct from the system of polar coordinates, is by no means as distinct as many discussions would indicate. In the system proposed by Lieutenant Weaver, for example, the squares of the harbor chart may easily be considered as points plotted by polar coordinates expanded to definite areas, and numbered for future identification, the position of a target at any of which is checked by the D. P. F. in the Fire Commander's Station. Lieutenant Weaver's transparent scale and arc compose a polar relocater which gives the gun range and azimuth to the indicated point or area. From this point of view, Lieutenant Weaver's system was different only in the devices employed and in terminology, from the polar coordinates system recommended by the Board.

In its proposed system of fire control and direction, the Board borrowed plentifully from the English system then in force, as was but natural. Even the terms "Fire Control" and "Fire Direction" had been practically unknown in our service up to 1894, and were suggested by Lieutenant Lewis on account of their use in the English service. It seems probable from inspection of the report and the English "Garrison Artillery Drill" manuals of 1892 and 1895 (successive editions), that the Board had not yet seen the 1895 edition, as the designations of the different officers in the chain of command are similar to those in the English chain of command of 1892, omitting the designation "Battery Commander," a familiar one in our service, but first introduced into the English chain of command in the manual of 1895. Those curious as to details are therefore referred to the 1892 edition of Garrison Artillery Drill (English), which was undoubtedly a fruitful source of suggestions to the Board.

The organization suggested for an artillery command or fort is based on the gun as a unit, commanded by a "gun director." One or more guns, a number such as can be efficiently supervised by one officer and served by the same position finder, constitute a gun group, under a "group commander." Each group is served by a position finder station, and all such sta-

tions in a fire command are under command of a "range finder commander". This last officer, with all "position finding officers" (one in each station), and the several "group commanders" in a fire command are under direct orders of the "fire commander." One or more fire commands constitute the "fort," the largest unit provided for, commanded by a "fort commander."

Each Ft. C. should have a P. F. station from which he can "control" the fire of his several fire commands by "indicating" targets to the F. C.'s, ordering the kind of fire to be used on the different targets, reserving the fire of one or more groups or of one or more guns of a group, concentrating the fire of two or more groups or fire commands on any particular target, etc.. \* \* \* each F. C. would be provided with a P. F. station from which he can "direct" the fire of his groups through the P. F. of the group and specific orders as to kind of fire, etc., he sends direct to the G. C., in accordance with the orders of the Ft. C.; \* \* each group should be connected with a P. F. by which its fire can be directed, and with the F. C.

It will be seen that the functions of "fire control" are vested in the fort commander, those of "fire direction" in the fire commander. The functions of the group commander are purely supervisory. The gun director may convert P. F. data for his own gun, if supplied with the proper devices, and then lays and fires the gun under the direction of the group commander. In regard to this conversion of data and application of necessary corrections, the Board expresses itself as yet undecided as to the proper place for performing these operations, but definitely states the necessity for mechanical devices and for the elimination of methods of computation as far as possible.

The board believes that, whenever possible, the method of indirect laying should be used; since it is convinced that, for seacoast artillery, guns can be more accurately laid to a mark (on traverse circle for direction and on elevation indicator for elevation) than by means of a telescopic or other sight.

The Rafferty Relocator and Millar Converter Board are mentioned as satisfactory methods of mechanical conversion of data; but, "as to means of making mechanically the corrections for drift, atmospheric conditions, etc., to be applied to the elements for the gun, no device has come officially before our board."

In extension and elaboration of some of the ideas expressed above, the Board introduces into the report a suggested Pointing Drill for Indirect Laying, in which twenty second observing intervals are proposed, the first shot to be fired after two minutes, subsequent shots at one minute predicting intervals. Time interval bells are recommended, and the gun director is intended to fire the gun a length of time in advance of the

expiration of the predicting interval equal to the time of flight (set-back point). Communication of data by means of a printing telegraph or other visible writing device is recommended. The details of the drill and duties of different numbers are prescribed, but must be omitted in this article.

The subject of "means and lines of communications" was deemed so important that Lieutenant Lewis was appointed a sub-committee to prepare a special report thereon, and this report is appended to the report of the Board. As this report is a discussion of the electrical problem involved in the interconnection of several stations it is omitted from present consideration as being to a large degree independent of the line of development of our artillery system. It is to be noted that the reliability of the telephone is distrusted, and the necessity of a duplicate or independent installation insisted upon. Underground wires and protected stations are noted among the first requisites.

The value of this report to the Artillery can hardly be overestimated, notwithstanding that Colonel Charles L. Phillips, Coast Artillery Corps, in a letter to the writer in regard to the present paper, says, referring to the period previous to the Pensacola tests in 1903, "Whatever evolution there may have been was rather in the development of our knowledge as to what were the requirements of the service;" and notwithstanding that other officers place the beginning of real progress at the time of the creation of the office of Chief of Artillery, in 1901. For though the first complete working system of fire control and direction was, indeed, published to the Corps as a result of the labors of the Tiernon-Story-Pratt Board, worked out at Pensacola by Major Whistler; and though the Office of the Chief of Artillery encouraged and made possible a movement of progress in the whole art of artillery in comparison with which any previous progress may appear negligible; yet three years before the earlier of these two events there had been issued the first Drill Regulations for Coast Artillery, publishing to the service a complete system of fire control and direction, in the most general terms, for the most part, it is true, but still complete. Those Regulations had been based on and expanded from the system embodied by the Board on Regulation of Seacoast Artillery Fire in its report of 1896, previous to which time the terms *fire control* and *fire direction* had been hardly understood in this country, the position finding service being merely a theory, and the systematic development of

either by a complete system of communications a thing untried and not hinted at in any publication of general distribution. Unfortunately, the report itself had no general distribution, and hence its effect was small until after the publication in 1898 of the Drill Regulations based upon it.

In August of the same year the Board submitted a report on two forms of devices for "making mechanically the corrections for drift, atmospheric conditions, etc.," the necessity for which had been stated in their report on the system of fire control. These were the Millar slide rule correction table and the Rafferty deviation index. The Millar apparatus afforded a general solution, applying all corrections; while the Rafferty device gave a quick mechanical solution of the problem, applying the corrections for wind, drift, and  $\frac{\delta_1}{\delta}$ , omitting consideration of corrections for elevation of battery, velocity, density of loading, weight of projectile, etc., all of which were included in the Millar device. The Board reported that both accomplished the same result in practically the same time, both were simple in construction and use, and the operation of both quickly learned by enlisted men. The Millar device, as suggested in its name, is a combination of thirteen separate slides and two discs, each applying a different correction. The Rafferty device applies the corrections noted by means of two concentric discs and a radial arm with a sliding scale mounted thereon. It is substantially a wind component indicator with an attached mechanical adding device for including the  $\frac{\delta_1}{\delta}$  correction in the final result, and adapted also for the conversion of deviating components into minutes of deflection or elevation.

Among other subjects reported on by this Board during the year were a printing telegraph, a "Target Indicator" submitted by Lieutenant Arthur Murray, 1st Artillery, a "Range and Azimuth Signalling Device" submitted by Lieutenant Fiske, U. S. N., and a "System of Range and Position Finding with Converter Board," submitted by Lieutenant C. L. Best, 1st Artillery. Consideration of these is omitted, as they are outside the direct line of development under discussion and were never recommended by the Board for adoption.

About this time (late in 1896), it was thought advisable to change the complexion of the Board on Regulation of Seacoast Artillery Fire and to put at its head an officer of rank, so that

the conclusions and recommendations emanating from it would have more weight than those put forth by "irresponsible first lieutenants," as some in the service were wont to say. Pursuant, therefore, to Special Orders No. 302, Adjutant General's Office, series 1896, Colonel John I. Rodgers, 5th Artillery, assumed the duties of president of the Board, and 1st Lieut. C. F. Parker, 2nd Artillery, was detailed as a member, Lieutenants Rafferty and Lewis being relieved. The same order detailed Lieutenant Lewis for duty in connection with the installation by the Board of the type fire control system at Fort Wadsworth. A later order detailed First Lieutenant W. H. Coffin, 5th Artillery, as an additional member of the Board. The duties and records of the Range Finder Board had been transferred to the Board on Regulation of Seacoast Artillery Fire by Special Orders No. 155 of the same year, and Major Knight, representing the Corps of Engineers, and Captain Hobbs, representing the Ordnance Department, members of the defunct Range Finder Board, had been detailed as additional members of the new board for purposes of consideration of range and position finders only.

The new Board, during the year 1896-1897, reported as unsuited to the needs of the service the Sheehy telotype, Captain Best's converter board, a range and position finder offered by Captain S. E. Stuart of the Ordnance, and the Phillips relocater. The only tangible advance noted is the development of an emergency D. P. F., the Rafferty, the Lewis, and the Barr and Stroud instruments having been tested, and the Rafferty and the Lewis instruments both found suitable. The Lewis instrument was recommended tentatively, but in a later report the Lewis and Rafferty types were decided to be so equally suited to the needs of the service that the question of price was left to decide which should be purchased. The type of Lewis instrument adopted for the service is fully described in an excerpt from the Report of the Chief of Ordnance, with photographs, reprinted in the JOURNAL, No. 2, Vol. 8 (1897). The emergency type is simply a portable modification of this instrument. No. 1, Vol. 7 (1897), of the JOURNAL, contains full descriptions, with photographs, of the Squier-Crehore A. C. Range Finder and the Barr and Stroud 4-½ foot instrument.

In No 3, Vol. 7 (1897), of the JOURNAL, is published the report of a board convened at the Artillery School, composed of Captains Ingalls and Story and Lieutenant Ruckman, to consider the question of parallel versus independent laying of the



respective mortars in a group, which question had been brought up in a paper by Lieutenant Honeycutt. It is without the scope of this paper to do more than mention the existence of this conflict of opinion, which disappeared as the methods of fire direction became such as to get greater accuracy from mortars, and indeed other guns, than was at that time contemplated. The discussion of the question of probability of hitting, etc., contained in this report is very complete.

In June 1898, the Squier-Crehore Range Finder was tested by a board at Fort Monroe, with satisfactory results. It is interesting to note, however, that the alternating current feature, whereby the distant station controlled the position of its arm on the plotting board, was entirely abandoned by the inventors in favor of telephonic communication between stations, the secondary arm being set by hand. The word "arm" in this case is somewhat of a misnomer, as the two sides of the range triangle ordinarily formed in plotting boards by material arms of wood or metal, were, in this instrument, formed by narrow beams of light which formed a dark triangle at their intersection, giving very accurate locations, and disclosing the whole board and the chart thereon.

The Board on Regulation of Seacoast Artillery Fire was engaged during the year for the most part in the revision and correction of the proof of the text and plates of the new drill regulations, and in computing range tables and gun-commanders' range-scales for the different guns comprising the seacoast armament. Several members were at different times on active duty in the field, and there is no report of tests of definite importance. Work was cut short by the outbreak of the war with Spain, which scattered the members of the board. The drill regulations, with plates, were, however, finished in April and published to the service in May.

No better characterization of these regulations is possible than will be found in the following quotation from a letter of General John I. Rodgers, now retired, then colonel, 5th Artillery, president of the Board.

It seemed absurd to attempt to prepare Drill Regulations at this time, for there was no permanent Sea Coast Armament in place, the guns, carriages, equipments and emplacements being in the experimental stage of development. In view of this limited progress in the construction of the new fortifications and armament, I thought it advisable the Board should begin its work by laying down the *principles* governing Coast Defense, analysing the subject and clearly defining what was comprised in the term, describing the nature and character of the attack that might be delivered and the scope of



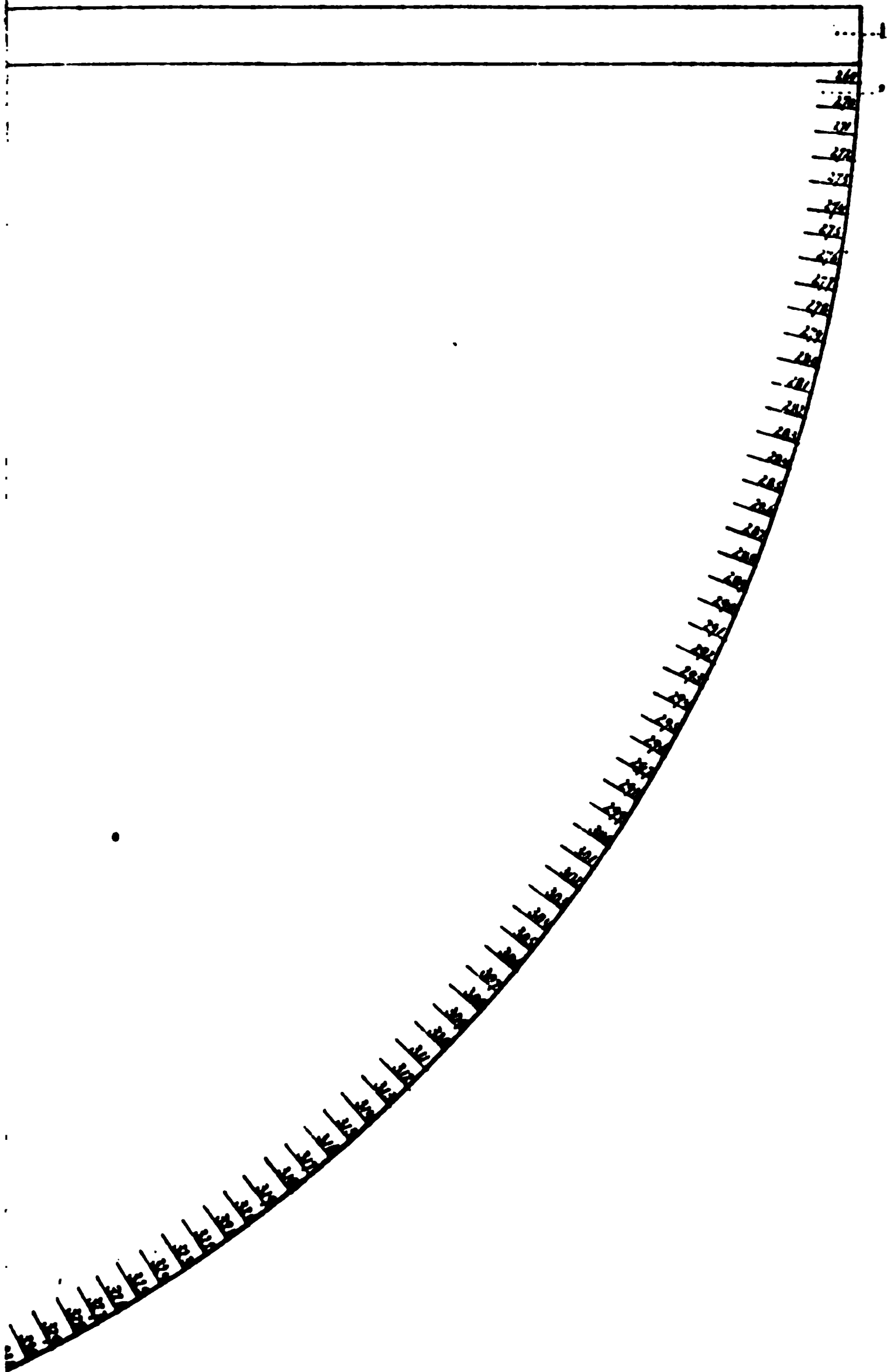
the operations necessary for the defense, arranging and employing all the means as a tactical command in order to insure an effective, judicious and orderly administration of fire. \* \* \* \* \* The accessory means needed to insure correct, rapid and effective administration and control of fire, such as base lines, observing stations, and communications were treated in the same way, first describing the object to be attained and then prescribing the *principles* which should be observed in their location and the connection of the communications with the guns and the Battery and Fire Commander stations.

Most officers, including a majority of the members of the Board, were inclined, I think, to the vertical base system on account of its apparent simplicity, and also on account of the length and difficulties of rapid and accurate communication involved in the horizontal base system. It was my judgment, however, that the vertical base instruments, with their variation in accuracy, depending on elevation of site, tide, atmosphere and range check marks, and particularly with conspicuous artificial towers, would not satisfy the requirements of the service at a critical time. I knew the mathematical way to determine the location of an inaccessible point was by triangulation, and I hoped in time the problem of reliable and rapid communication might be solved, and the Board at my instance made provision authorizing the use of the horizontal base system on low sites.

The Board endeavored all through its work to give a tactical direction to the organization of the Artillery Service and make provision for emplacement and disposition of batteries and armament on tactical principles for effective control and application of fire.

Under the conditions of development of the matériel above noted, no other or more detailed character of regulations would have had any practical value whatever; and in regard to the position finding service in particular, with few instruments of any sort adopted for use, and none standard, we find these regulations to be of much the same character as Artillery Circular E of 1893, *i.e.*, rather a description of the state of the art at the time, with outlines as to what may be done (if by chance matériel is available), than exactly prescribed details of a standard system, such as is ordinarily expected in drill regulations.

The following matériel is illustrated in the plates and thoroughly described in the text: Lewis D. P. F., Types A and B; Rafferty D. P. F.; a replotting device designed by the Board; the Rafferty relocater; an instrument for observation of fire, designed by the Board, with the functions of our present azimuth instrument; an anemometer and clock; a wind component indicating device, with dials and arm like those of the present device, but without the reference number idea, zero being at the center; Fire and Battery Commanders' identification and battle charts; Gun Commanders' Difference charts; and a graphic chart for obtaining  $\frac{\partial_1}{\partial}$ . The telephone and tele-



TTING DEVICE



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graph, and the printing and dial telegraphs are mentioned as means of communication, but not described, nor are instructions given as to their use.

The replotting device designed by the Board is worthy of especial mention, as it embodies several principles which have been incorporated in our present standard board. There were three arms, one for each station and one for the directing gun, each mounted on its own fixed center, properly related to the others in distance and azimuth according to the scale of the board. The azimuth circle was described about the gun arm as its center, and this arm acted, after the manner of our present "auxiliary arm," in setting either of the station arms to a desired azimuth, the three arms being connected at their movable ends by coupling spanners which maintained them always parallel. The station arms were set one after the other, and the setting marked on the board by a pencil carried by a slide on the arm. The gun arm was then brought up to the penciled intersection, and its range and azimuth read from the arm scale and azimuth circle respectively.

In 1899 the type artillery fire command was completed at Fort Wadsworth and turned over to the artillery garrison at that post. The report of the Board of Ordnance and Fortification for that year expresses the hope that "the daily practical drills conducted there will serve to point out for correction whatever defects or deficiencies may at present exist in the recently adopted drill regulations for the coast artillery."

In January 1901 Captain Whistler submitted a report of the desired character, in which he pointed out the difficulties in the way of practical application of the system of fire control and direction laid down in the regulations, and gave full details of the changes and additions which he had found necessary in a year's drill and practice to obtain desirable facility and precision. Discarding the method of prediction which uses the rates of change of azimuth and range, as unsound and inaccurate, he utilized the plotted course of the vessel, with an auxiliary prediction scale, to get the predicted point; a chart and T-square to get the amount of set-back for a given range and travel; and a relocater to obtain the gun range and azimuth of the predicted point. A correction board containing corrections for atmosphere, tide, wind and muzzle velocity for each hundred yards of range, in tabular form, performed imperfectly the functions of the present range correction board. Corrections had to be taken from the board for each item and com-

bined arithmetically by computation and then applied to the relocated range in a similar manner. Case III alone was contemplated in the system proposed by his report, and a full detailed drill, with duties of different numbers of a position finding detail, practically valuable for actual firing at moving targets, is therein laid down for the first time. The report was published by the Adjutant General's Office in March, 1901, "for the information and guidance of all artillery officers, who will make a thorough test of the system during the approaching drill season."

A full description of the same system, with more extended discussion of principles and details, by Captain Whistler, appeared in the JOURNAL, No. 3, Vol. 15 (1901). The trouble caused by plus and minus signs for corrections is treated at some length, but the reference number idea was not to be brought out until the following year (by Captain E. W. Hubbard, Artillery Corps), the solution proposed at this time by Captain Whistler being a distinctly settled convention as to which corrections should be considered plus and which minus. The "rate" method of range and azimuth correction in predicted firing is noted to be worthless, when the angle of the vessel's course with the line of fire is less than forty-five degrees, and the whole drill employing the substituted plotting method is carefully described. The division of azimuth circles into degrees and hundredths is recommended as likely to avoid the errors due to adding or subtracting degrees and minutes. Under the heading "Fire Direction" is described the method of indicating targets to a battery by the prediction method, using D. P. F.'s, and the three "Cases" are discussed, Cases I and II being discarded except for ranges under 3000 yards. The necessity of including searchlights in the system is clearly recognized, a light for each battery and each F. C. station being recommended and designated "illuminating lights," in addition to others designated "search lights proper" and "blinding lights." In conclusion, Captain Whistler refers at some length to the conflict of opinion between officers in regard to horizontal and vertical base position finders, enumerating very fully the advantages and the disadvantages of both systems; and it may be remarked that there has been surprisingly little change of opinion in the matter since the time his article appeared.

The abnormal conditions accompanying the Spanish war had caused an interruption and temporary disorganization of the Artillery School at Fort Monroe. General Orders No. 58,

Headquarters of the Army, Adjutant General's Office, 1900, put the school again on a normal basis, and in addition established the Artillery Board in the following paragraph:

The Commandant of the school, together with the heads of the several departments, will constitute a board of artillery to which may be referred from time to time all subjects pertaining to artillery upon which the General Commanding the Army may desire their opinion and recommendation.

From its inception this Board, as is well known, has exercised a powerful and beneficent influence on the professional progress of the arm. The reorganization of 1901 left the personnel of the Board unchanged; but in 1905, owing to the increasing demands on the time of the Commandant and the heads of the departments of the school, the composition of the Board was changed by General Orders No. 156, War Department, 1905, paragraph 2 of which reads as follows:

Such Artillery officers as may be designated by the War Department shall constitute the Artillery Board, with station at Fort Monroe, Virginia, to which may be referred from time to time all subjects pertaining to Artillery upon which the War Department or the Chief of Artillery may desire the Board's opinion or recommendation. \* \* \*

Since the promulgation of the above order, the members of the Board have, with a few exceptions, been officers on duty with troops at Fort Monroe. The same order established a Torpedo Board and a Field Artillery Board in succeeding paragraphs.

On February 6, 1901, the Board of Ordnance and Fortification had recommended that a comparative test be instituted at Fort Wadsworth to determine the comparative merits of the horizontal and the vertical base systems, and also to determine the practical value of searchlights for coast defense; and subsequently at the March meeting an allotment of \$20,000 was made for mortar firing tests to be conducted with the mortar batteries in Portland Harbor, Maine. The results of those tests were to prove instructive, not only as to the mortars themselves, but also as to the general service of position finding.

In that year, also, the artillery was reorganized into a corps, and the first Chief of Artillery, Colonel Wallace F. Randolph, was appointed on April 9, 1901.

The matter of fire control communications had also been handled by a board appointed for that purpose, organized at Governor's Island by paragraph 17, Special Orders No. 136, Headquarters of the Army, Adjutant General's Office, 1900; and the Board of Ordnance and Fortification had approved the

recommenadtions of that board in so far as they prescribed telephonic communication between the fire commanders and superior commanders, with some type of "visual" communication, the Gray Telautograph being approved as a type, between fire commanders and battery commanders and between the battery commanders' stations and the guns, the latter being intended for both tactical orders and ballistic data. The proceedings of the two boards affecting this matter were published as Artillery Notes No. 4, in which was incorporated a paper on the installation of these communications by Major Whistler. Notes No. 6, concerning the telautograph alone, were subsequently issued, in 1902, having been prepared under the direction of General Greely, the Chief Signal Officer.

Paragraph 29, Special Orders No. 260, Headquarters of the Army, Adjutant General's Office, 1902, detailed to revise the Drill Regulations for Coast Artillery, a board composed of Colonel Story, Majors Lundeen and Whistler, and Captains Weaver and Bartlett. This board was organized in November 1902 at Fort Monroe, but did not publish its final results until 1906; so that the results of the various influences working from 1900 to 1905 may be said to have been compounded, harmonized and unified in the regulations of that year.

In addition to the influences already enumerated, there must be mentioned as of first importance the student officers' fire command practice at Fort Monroe under Captain Weaver in 1901. This was the first time a fire command had been operated as a unit in target practice at Fort Monroe, and probably the first time in the United States service. As there was but one position finder at the post, a Lewis D. P. F., the vertical base was used, and Case II was employed throughout for the direct fire guns. Thus the Artillery School classes, under the direction of Captain Weaver, developed the Case II idea, as opposed to Case III, which was advocated for exclusive use beyond 3000 yards by Captain Whistler, and later thoroughly tried out in the Pensacola firings of 1903. Mention should here be made, however, that on the Pacific coast Case II had an able advocate in Captain W. G. Haan.

The effect and value of the Portland firings of the fall of 1901 were general rather than specific, as far as the position finding service or fire control system was concerned. It was, of no small value to the officers of the Corps to have demonstrated conclusively that mortars were not necessarily limited to fire on anchored targets, but could be depended upon

for some hits on moving targets, even at the initial stage of development. As a result of these firings, report of which was published to the Corps as a confidential pamphlet in 1902, a host of suggestions as to methods and devices began to be received by the JOURNAL and by the various boards having fire control or position finding under consideration. Many of these devices will be touched upon later on.

The Wadsworth Board, consisting of Colonel Tiernon, Major Pratt, and Captain Whistler, convened in May, 1901, and on September 3rd of the same year submitted a report on a scheme of fire control and direction for immediate temporary use in instruction. The May-June, 1902, JOURNAL contains an extensive extract from this report, from which a few salient principles only can be quoted here.

The combination of a horizontal base with any D. P. F. system is laid down as a necessity, as either may fail under some conditions.

The Whistler plotting board is presented and described, with a sketch showing its details: auxiliary arm and coupling link; index boxes; base-line arm azimuth adjustment by an index-box; also secondary arm centers on either side of the main arm center. It is offered as a plotting board, but in the sketch as shown must be supplemented by a replotting device to get gun range and azimuth, if a horizontal base is used, as no gun arm is available in such a case. Captain Whistler speaks of it as a modification of the replotting device suggested by the drill regulations board of 1898, a sketch of which appears in the plates supplementing those regulations.

The set-back point is used, and set-back charts are illustrated.

The salvo order of firing will be used in predicted firing, by heavy coast batteries, using Case III.

Fire by piece using Case II will be used only when it is impracticable to use predicted fire.

As the system suggested in this report was worked out very thoroughly by Captain Whistler later in the Pensacola installation, we may satisfy ourselves for the present with the above brief excerpts.

Owing to the activity of the influences noted above, from 1900 to 1903 attention was largely concentrated on fire control and direction.

In No. 3, Vol. 15 (1901), of the JOURNAL, Captain Whistler, in an article on "Fire Control and Fire Direction," considers



the entire subject in practical detail. The necessary corrections are considered, with the methods and devices employed in applying them; a drill for a P. F. station is described in full; communication troubles are outlined; and a proper system suggested. Fire direction in general is discussed and its limits indicated, and the scope and value of the different cases presented. Fire control is then defined and discussed; the necessity for searchlights, and their functions and character, are considered; and the article closes with a discussion of horizontal versus depression system of position finding. This is among the most valuable contributions on the subject, and is worth careful study, though some of its conclusions have since been abandoned.

Captain Weaver first presents the Case II idea in his report of the Artillery School target practice of 1901, published in the *JOURNAL* No. 1, Vol. 17 (1902). As previously noted, a depression position finder, the only one at the post, was employed. The time-range-relation board was used to good effect. The range rake, in nearly its present form, is incidentally described. The battery commander's position in action is claimed to be at the guns, and a location for the plotting room nearly that now standard is suggested. Six shots from mortars at a moving target were fired, with two hits, giving an early indication of the great value of that arm which has since been realized. Communications, search-lights and other details of the system were discussed at some length, and the relative values of the two types of position finder treated. No comment on the Wadsworth system is made, the differences of method appearing only as statements of fact. Outside of the fire control matter, there is a large number of comments and suggestions in regard to personnel and matériel, which are out of place in this paper, but which make Captain Weaver's article invaluable to the student of the art of coast defense.

The first comparison of the Case II and Case III systems is made by Captain W. G. Haan, in No. 3, Vol. 17 (1902), of the *JOURNAL*, commenting on Captain Weaver's report just mentioned. Captain Haan at the Presidio had developed Case II independently of the work under Captain Weaver at the School, and had tried out Case III as developed at Wadsworth in comparison with his own system, remaining convinced of the excellence of Case II. Captain Haan's analysis of the Fort Monroe report led him to ask many questions in regard to details of the Monroe practice, which Captain Weaver

answers fully, so that this article greatly enhances the value of the first report. In the same number is found a detailed description of the Fort Monroe system of Fire direction under the caption "A Battery Manning Drill." In No. 3, Vol. 18 (1902), of the JOURNAL, Captain Haan reports fully on his trial, at Battery Cranston, of the Wadsworth system, claiming, among other defects, that it requires a degree of expertness among the enlisted personnel which can hardly be expected in service. He fully describes his own Case II methods, and gives a P. F. manual and various forms and tables used. Captain Whistler's remarks on the report in the same number include an exposition of the fundamental principles on which he relies to justify, or, in fact, to require the use of Case III. This is another most valuable contribution to the subject. The discussion was continued by Captain Haan in No. 2, Vol. 19 (1903), of the JOURNAL. In No. 3 of the same volume Captain Wilmot E. Ellis reports on the Wadsworth system of Fire Direction, in which he ranges himself on the side of the Case II school.

In No. 2, Vol 20 (1903), we find the report of the student officers' firings at Monroe of that year, in which Major Weaver describes their successful experiments in more advanced fire control, changing targets, etc.

The subject of position finders from 1900 to 1903 attracted little interest, although a few new types were submitted to the Board of Ordnance and Fortification. This Board was considering the remedies for certain defects in the Lewis instrument, largely due to lack of stiffness in the large table necessary with the replotting device. Through the columns of the JOURNAL, Captain Pence offered a short-range instrument employing the principle of the camera obscura; and Meigs, formerly of the Navy, then with the Bethlehem Steel Company, devised, and described in the JOURNAL, a combination of position finder and plotting board which gave continuous readings of predicted ranges and azimuths, as long as the telescope of the primary was kept on the target and the secondary arm was kept set to secondary azimuths. Neither of these interesting departures has affected our present practice.

Individual officers throughout the service were working on various devices for correcting, relocating, and predicting. Captain C. L. Phillips presented to the board a "Universal Difference Disk," which was tested at Wadsworth and Monroe but finally not adopted, and a "Replotting Board," fifty of

which were constructed and distributed to posts for test. This had an azimuth circle and arm for the P. F. station, and a series of range circles on a celluloid sheet adapted to be adjusted with reference to the P. F. center. The relocated range was read from the circles. Relocated azimuth was not obtained. This device was finally (in 1904) stated to have been "found to be less satisfactory than other devices subsequently adopted." The Whistler board with Hearn gun arm had by then cleared the field of competitive devices. The Rafferty relocater, previously described, was another device finally discarded in 1904, as not being superior to devices adopted. The Cloke ballistic board was tested by the Artillery Board in 1903, and found to be less accurate than the method using Major Whistler's tables published in his report on "Fire Control and Fire Direction" of 1901, beside being very costly to construct. In 1902 the Prentiss Dial Telegraph also was finally tested at Wadsworth and recommended not to be adopted.

The Pratt ballistic board was first submitted to the Artillery Board in December, 1902. This device applied to the actual range, set off on the horizontal ruler, the corrections for atmosphere, wind, muzzle velocity, and tide. There was no prediction correction device, and the vertical scale was an equicrescent scale of ranges. This was tested out in competition with Major Whistler's tables, as the Cloke board had been, and was found to be more accurate and quicker in its operation, so was recommended for adoption.

In No. 1, Vol. 18 (1902), of the JOURNAL Major Best describes a mortar plotting board in which the azimuth corrections for drift are applied by means of a succession of drift curves, one for each zone, cut into a "drift ruler." This is used in combination with a single range arm on which are inscribed opposite each range the charge, elevation, time of flight and drift correction for the zone or zones appropriate to the range. Relocation is effected by the shifting center of the range arm, originally devised, it is believed, by Lieutenant Frohwitter, an azimuth circle with diagonal vernier being drawn about each center employed. The drift ruler automatically subtracted the drift correction azimuth from the target azimuth at any range. In the following number of the JOURNAL (No. 2, Vol. 18), Captain H. G. Bishop describes a new form of set-back chart for mortars, and Lieutenant P. C. Hains, jr., a predicting and set-back ruler. Neither of these are represented in our present system, but are mentioned in order to give an idea of the trend

of effort at this time. In No. 3 of the same volume of the JOURNAL, is described a "Graphical Chart for Showing Sight Deviations for Sea Coast Guns" devised by Captain Hamilton Rowan, on the same lines as the ballistic board of Major Pratt. This appears to have been the first published description of a method of applying the chart curve idea to corrections for travel. Wind and drift corrections are also thereby applied. It may well be possible that the ultimate incorporation of the travel scale in the Pratt range boards was due to the suggestion by Captain Rowan of the use of such curves on what is practically a deflection board. The idea is certainly represented in the range boards of to-day, though for deflection corrections a device of a different character is used.

In No. 2, Vol. 19 (1903), of the JOURNAL, Lieutenant P. C. Hains, jr., shows a gun arm applied to his difference-circle plotting board. The primary and secondary arms are represented by the old silk thread, but the gun data are read from a metal arm mounted on the gun center. No correction devices are incorporated in the design of this arm. In the same number Captain Frank W. Coe presents a predicting and *set-forward* ruler of unusual design; and the ruler used by the companies at Fort Monroe for determining the predicted and set-forward point is also described. The Fort Monroe ruler is of the simplest pattern, adapted for a two minute prediction, with a table of travel in yards during the time of flight engraved on the scale. It must be noted that the set-forward instead of the set-back point is used in the systems for which these rulers are adapted. The use of the set-forward point, it is believed, was first suggested at Fort Monroe by Lieut. H. L. Butler, in the course of a lecture given to the officers of the post in 1902 by Captain Weaver, instructor in the School.

In April, 1903, the Wadsworth system was finally installed and thoroughly tried out at Pensacola. "This test, authorized by the Secretary of War, upon the recommendation of the Board of Ordnance and Fortification, was primarily to determine upon a system of fire control and fire direction which would be immediately available for universal installment," and a board of officers at Fort Wadsworth, with Colonel Tiernon as president, was originally intrusted with the drawing up of the program. As the program developed, it became apparent that New York harbor was unsuitable for so extensive a series of tests, and after an examination by Major Whistler, and on his report, Pensacola harbor was selected. Here the system pro-

posed by the Wadsworth board was installed by Major Whistler, under the direction of and with the enthusiastic cooperation of Colonel Mills, then the District Commander, and ably assisted by Major H. L. Harris, "without whose unrelenting interest and indefatigable work the results obtained in the test would have been impossible."

The salient feature of the Wadsworth system, as it appears in the reports on the Pensacola tests, is the grouping of all battery commanders of a fire command in a *general fire command station*, so that the fire commander has easy access to each of his battery commanders, and can exercise the functions of fire control by personal direction and indication of targets instead of through a system of communications. This grouping was obtained by using a system of parallel base lines of equal length, overlapping only enough to allow a separate base end station for each base line. These base end stations at one end of the system formed the battery commanders' stations of the fire command; and the group, in connection with a fire commander's station, formed the general fire-control station, all stations being connected by a sheltered walk.

This feature of the recommendations of the Wadsworth board is so radically different from the corresponding features of the present standard system that the following quotation from the report of the district commander, Colonel Samuel M. Mills, must be of permanent interest as indicating the reasons for the arrangement of stations advocated:

The control of fire by one individual, which is a marked feature of this system, is especially deserving attention and approval.

In our service in time of war we can not hope to have—we never have had—trained and experienced battery commanders with their proper commands. They have always heretofore been taken away for field and general officers of volunteers, so that we will be left dependent upon lieutenants as battery commanders, who have had probably little or not much experience and training. We can only hope for, and probably will have for each defensive position one expert and trained fire commander, who, under this system, has absolute control and direction of the fire of the artillery defenses, and not be left to the uncertain, irregular, and uncontrolled fire of individual battery commanders.

In this connection we must note also Major Whistler's exposition of the fundamental requirements of our service, to meet which the Wadsworth system was devised. That exposition is included in Major Whistler's remarks on Captain Haan's report of firings at Battery Cranston, published in No. 3, Vol. 18 (1902), of the JOURNAL.

The point of next importance for which the Wadsworth Board stood was the use of Case III whenever possible, as preferable to Case II. In this respect, however, the members of the Board had experienced considerable modification of opinion since the first report on "Fire Control and Fire Direction" published in 1901; for although they still stood no less positively for Case III, yet the value of Case II seems to have been more fully appreciated, and its efficient use conceded to be possible, contingent on the supply of improvements in the methods of sighting.

The question of horizontal versus vertical base was settled by the Board by compromise, the horizontal base ends being equipped with depression position finders. It was noted in the reports that neither horizontal nor vertical base alone was able to satisfy all requirements; but it was claimed that the combination of the two systems had a universal application, whatever the elevation of the site, and must be expected to come very near solving the problem.

A further postulate of the Wadsworth Board's was that the battery commander should fight his battery from the primary observing station, not from any point necessarily near the guns. The location of the battery commanders' stations in groups at the ends of their respective base lines for fire control purposes at once follows.

For a full description of the tests, with the reports of all officers engaged, and the action of the Chief of Artillery, General Randolph, thereon, the reader is referred to the confidential pamphlet of 1903, issued at that time to all officers. The Whistler plotting board, the Pratt ballistic board, and the telautograph were all essential details of the system, and were adopted as standard elements in the report of the Chief of Artillery. A set-back and predicting scale devised by Captain Bottoms and modified by Captain Hearn was utilized with success, and led to the incorporation of a "predicting scale" in the approved list of material. Other items of the list were the Warner & Swasey position finder; time interval clocks and bells controlled by one master clock for a post; a wind-component device; a time-range relation chart; an aeroscope connected with a tide gauge. All of these were of forms with which officers throughout the service are thoroughly familiar, though some are not now parts of the standard installation. The Warner and Swasey instrument was on this occasion tested for the first time in actual firings. The time interval clock



system was a Signal Corps design. The aeroscopes were built by the telautograph company on the suggestions of Major Whistler.

The completed reports of the tests were referred to the Board of Ordnance and Fortification, and by them to the Chief of Artillery, General Randolph, whose report was approved by the Board and by the Secretary of War. General Randolph analyzed not only the system of fire control used at Pensacola, but the whole installation and the necessary implements, devices, and other matériel, and in his report laid down certain principles to govern the service in fire control work, and drew up a complete list of all equipment necessary for the different stations in the approved system. Beside the Pensacola tests, he had before him for consideration the results obtained at Fort Monroe under the system developed there since 1901; and the Monroe school, which advocated Case II as a main reliance, was preferred by him to the Wadsworth idea.

The principles laid down by General Randolph are in brief as follows:

(1) The Battery Commander's legitimate position is at the guns.

This was a claim of the Fort Monroe school, and in direct opposition to a fundamental principle on which the Wadsworth system was based. The general fire control station of the Wadsworth Board was, however, still contemplated; but the fire commander was to communicate his orders verbally to range officers in the grouped base end stations instead of to the battery commanders.

(2) Case II, though not necessarily to be used to the exclusion of Case III, is always to be preferred thereto.

This Case was developed by the student officers at Fort Monroe about 1901, under the direction of Major Weaver. As has been noted already, the use of Case II was contemplated by the Wadsworth Board under certain conditions for short and middle ranges, but Case III was believed by that board to be the normally correct and satisfactory solution of the problem.

(3) Horizontal base lines, with depression position finders at the base ends for identification and other purposes, are necessary for all batteries and fire commands. All base lines in a command should, when possible, be parallel and have grouped base end stations.

This item, with nearly all details of the mechanical installation was due to the success of the Pensacola tests. It may

be well to quote here from General Story's "Recommendations Relative to Changes in Equipment" of 1905, wherein he says, "The conclusion was reached that the Fort Monroe system was superior to the Pensacola system, but that the Pensacola equipment was superior to the Fort Monroe equipment, and very well adapted to the Monroe system."

The Board of Ordnance and Fortification approved the recommendations of General Randolph both as to system and as to matériel; recommended the printing and confidential distribution of the report to all officers; and, most properly, voted an appreciation of the work of Major Whistler in bringing the tests to a successful and satisfactory conclusion.

In approving the action of the Board of Ordnance and Fortification on General Randolph's report just noted, the Secretary of War brought into being the first standard, complete, and consistent system for the defense of our seacoast. We may then with propriety terminate the Period of Crystallization with the publishing to the service of the report of the Pensacola firings, and call the period subsequent to that report a Period of Filtration, or Refinement.

On examination of the system and the list of matériel approved at that time, we find represented every item of our present position finding equipment, except the deflection board; while the tactical organization and chain of command is practically identical with our present one, and the system of fire control and direction is in essentials the same as that now standard and included in the single term fire control. Whereas, therefore, the invention or perfection of individual mechanisms up to 1903 could, and in many instances did change the line of development of the position finding service and system of fire control, we find that from that date to the present the established systems have quite narrowly limited the extent and direction of development of instruments and devices. The reports of the tests of both the Monroe and the Wadsworth systems had been so thoroughly discussed, and their relative excellences advanced and ultimately reconciled by officers of such recognized authority and scientific attainment, that the approved standard system was accepted by the entire corps, and the development of its details was immediately undertaken by many individuals.

The files of the JOURNAL, as usual, indicate the trend of work, and Vol. 21 is particularly interesting and valuable to the student. In an article on "The Gunner's Corrector and



Improved Deflection Scale" in No. 2 of that volume, the reference number principle is advanced by Captain E. W. Hubbard, to whom it is believed the first suggestion of this principle should be credited. Captain Hubbard had been working on this principle since 1902. In Vol. 21 also is the first published description of the Hearn gun arm for attachment to the Whistler plotting board, which appears in full with photographs in the same number under the caption, "Proposed System of Fire Direction." The gun arm shown therein is not exactly of the standard general form, but of a special form, adapted for use when the primary station is very near the directing point of the guns, and it does duty as both primary and gun arms. The principle of the range corrector slide is plainly shown, although the azimuth tally dials are not a part of the device illustrated in the article. Two boards with T-squares, strings, and sliding rulers, are offered for use in determining the travel corrections for range and azimuth. The principles of the range corrector board were later incorporated in the travel scale of the Pratt range board. The T-square, sliding scale, and radial string developed into the "travel" details of the deflection board, and the wind and drift corrector arm and leaf were added shortly afterward, the completed form first appearing in the drill regulations of 1906.

Other articles worthy of note in Volume 21 are: in No. 1, descriptions of a "Semi-automatic Sight," an invention of Captains E. W. Hubbard and S. C. Vestal, Artillery Corps; a combination "Range and Drift Ruler for Mortars," by Captain P. P. Bishop; and a "Device for Drift Correction and a New Set-Forward Ruler" by Corporal O. Van Beek; in No. 2, "Fire Direction as used at Battery Sullivan, Fort Williams, Me.," by Captain W. C. Davis, showing methods of making gunners' corrections, and also a form of Time-Range Board; and "A Modified Time-Range-Relation Board," by Captain Henry Hatch; and in No. 3, a "Range and Drift Ruler for Mortars," devised and described by Captain R. E. Wyllie; a "Semi-automatic Predicting and Set-back Ruler," by Captain P. C. Hains, Jr.; and a "Range Scale for Difference Chart for Mortar Battery," by Corporal F. W. Winter.

In this year (1904) the work of the Drill Regulations Revision Board was first communicated to the service by the issuing of the gun drill and gunnery portions to the various companies for test. The position finding pamphlet appeared during the next year, and will be taken up later.

The JOURNAL has but two contributions to our subject in 1905, both in regard to mortar work, as were the majority of those of 1904. Captain Johnson Hagood presents a "Gun Arm for a Mortar Battery Plotting Board" in No. 1, Vol. 23 (1905); and in No. 1, Vol. 24 (1905), Captain S. C. Vestal presents a suggestion for modifications of the time-range-relation board, offered by Captain Hatch in the preceding year, to afford "Range and Azimuth Boards for Mortars."

Captain W. C. Davis published in No. 2, Vol. 25 (1906), of the JOURNAL, a proposed arrangement of an "Electrical Signalling and Firing Device for Mortar Batteries," and Lieutenant Hyde offered a Mine Prediction Board in No. 2, Vol. 25 (1906).

This brings us to the revised Drill Regulations of 1906, and it may be interesting to consider somewhat in detail the standard systems and devices included in them, tracing briefly the development of each in a sort of résumé of the subject up to this point. The Drill Regulations Board, with the assistance of the Artillery Board sitting at the same post, may be considered to have digested all of the devices and other propositions mentioned in these pages, with numberless others of which no description is easily available, and to have picked from among them all devices and principles best suited to a consistent development of the standard system. The results of their labors are, in the larger sense, the fruit of the efforts and development of the entire Artillery Corps, which, indeed, they very creditably represent.

In regard to systems of position finding and fire control, little need be said, as the previous comments on the Wadsworth and Monroe schools of thought and the illuminating tests and reports of the two systems must be sufficient. General Randolph's conclusions were accurately developed, where not already complete in themselves, in the regulations, the only change being in terminology, the "fort commander" of the Pensacola report being designated "battle commander" in the regulations. "Fire direction," as a definite term, is eliminated from our terminology, the term "fire control" being used to designate the functions of the battery commander as well as of the fire and battle commanders. The battery commander is assumed to exercise at all times a certain "limited fire control," there being included in that term all the functions of identifying, designating, and attacking a target, the limitations being

such as may be set by superior commanders in their more general exercise of a similar function.

Nearly every class of communication is represented: telautograph, telephone, aeroscope, and megaphone, and a time-interval clock with its system of bells. As the development of this part of our system has always been, especially as regards telephones and their usefulness, dependent rather on the progress of civil manufacture and broad scientific principles than on the development of the art of coast defense, this subject must be dismissed with this brief mention. It is unfortunate that a thorough technical monograph on the development of our system of communications and its devices should not have been prepared before this time, but no proper treatment of the subject can be included in this paper.

The same remark applies to a certain extent to position finders, as their change and development has been along the lines of details of the various devices and increasing perfection of the optical elements of the telescopes, rather than in any general principles; and the student must be referred to the various ordnance manuals and reports of extensive tests published in the JOURNAL. From time to time the reports of the Board of Ordnance and Fortification note the purchase or test of a new position finder, and these items have been noted in this paper. It is interesting to note here only that there were in use, at the time the drill regulations were prepared and published, instruments by Lewis (Types A and B), by the Warner and Swasey company, and by Rafferty. The drill regulations board made no attempt to standardize this feature of the system and left even descriptions to the ordnance manuals. From the fact that soon after this time exhaustive comparative tests were undertaken, it may be deduced that no certainty then existed as to the best type.

The equipment of the "primary station," which included also what we now know as the "plotting room," may be profitably reviewed.

The plotting board was the Whistler-Hearn type, descended from the old "string" board with double azimuth circles, through the Whistler type with auxiliary arm and spanner, and with Captain Hearn's correction box and tally dials applied to the gun arm. There is no essential difference between it and the present type, though minor details of construction have been changed.

The Pratt range board was also practically identical with

the type now in use. It had not the metal travel device, but had two travel scales on the blue print chart; and the actual and not the corrected ranges were used as arguments. The latter difference, it is now recognized, was a point of superiority, to which we must soon revert. The Pratt range board was developed, in part, from Whistler's graphic tables of fire with the Pratt ballistic board as an intermediate step; while the travel scale, as before mentioned, may have been suggested by Captain Rowan's use of a similar scale for determining deflections.

The deflection board, as previously noted, is a legitimate development of Captain Hearn's board for determining "Deflection for Travel", suggested by him in his article "Proposed System of Fire Direction" in No. 2, Vol. 21 (1904), of the JOURNAL. No essential change has since been made in this board.

The wind component indicator had been in use nearly in the form presented in the regulations since 1896, and was due at that time to Lieutenant H. C. Davis and Lieutenant Albert Todd. The only essential change which had been made was in the use of reference numbers instead of the old plus and minus values either side of zero correction. As previously noted, the use of reference numbers must be credited to Captain Elmer W. Hubbard, who first employed the principle in 1902 and published it to the corps in his article on "The Gunner's Corrector and Improved Deflection Scale" in the JOURNAL, No. 2, Vol. 21 (1904). The reference number principle was, of course, not restricted to the wind component indicator, but was applied, as at present, to all the devices of the system.

Among devices not previously referred to, which were evolved by the Board to meet the needs of the system, were the atmosphere board and the powder chart, each in the form now used. Both are no more than graphic presentations of data, from which other data may be taken for use in the practical ballistic problem, by partially mechanical methods.

The various devices in addition to the above, and the variations in the plotting board design, necessary for mortar firing by Case III, were only suggested in the text of these regulations, in which we find a note as follows:

The equipment for Mortar Battery Primary Stations is still the subject of test by the Drill Board. The position finding service herein prescribed is based upon this equipment, and will be subject to modification to accord with the finally adopted equipment.

The additional equipment indicated, but not described,

in the regulations includes a prediction scale, a set-forward chart, pit signals, etc. The operation of a prediction board is described, which consisted of a concentric dial and arm within a scale of azimuths. Step by step movement of these gave azimuths of predicted points.

The mortar system as actually used included an "azimuth sub-scale" which corrected for drift and permitted the application of arbitrary corrections. This was supplanted by the present mortar deflection scale, the "sausage machine," which was designed and approved in 1906, though not issued to the service for a long time afterward.

It is hardly profitable to consider in detail the years since 1906, as almost all the variations from the types of devices which formed the standard system of the 1906 regulations, are unimportant in character and effect, and nearly if not quite all of the 1906 matériel is to be found still in service at one or another post. The younger officers in the Corps, who have not watched the development of the system and matériel from that date, may inform themselves fully by reference to official publications and to the files of the JOURNAL. In fact, the field of an historical sketch, strictly considered, should stop short of that year, as the effect and value of subsequent developments, being of so recent date, cannot be considered in their proper relationship, until a longer interval of time than has yet elapsed shall have made possible a true perspective.

Touching, therefore, but briefly on the progress since 1906, we note the change, in that year, from actual to corrected range as an argument in the Pratt range board. The year 1907 saw extensive competitive tests of depression position finders [see Nos. 1 and 3, Vol. 29 (1908), JOURNAL OF THE UNITED STATES ARTILLERY], as a result of which the new Lewis instrument was adopted as the standard type. The competing instruments were the Rafferty, the Warner and Swasey, the Whistler-Hearn, and the Bausch-Lomb-Saegmuller types. In 1908 a standard self contained instrument was selected, the Barr and Stroud, with which all are now familiar. It was selected in competition with instruments offered by the Warner and Swasey Company and by Bausch-Lomb-Saegmuller. For the record of these tests see the JOURNAL, No. 3, Vol. 30 (1908).

Mechanical range transmission was first put prominently before the officers of the Corps in an article by Captain C. M. Seaman in the JOURNAL, No. 3, Vol. 32 (1909), in which he described the system which had been installed at Battery

Eustis, at Fort Monroe. The subject has since been developed so that some form of mechanical or electro-mechanical transmission occurs in many places in our system.

A competitive test of the Warner and Swasey, Bausch and Lomb, and Frankford Arsenal types of azimuth instruments late in 1909 resulted in the choice of the Warner and Swasey type as standard. See the JOURNAL No. 1, Vol. 33 (1910), for a full report of the tests.

During the same years frequent suggestions appear for improvement in the various devices employed in the system, principally those used by mortar batteries, there being many suggestions for checking devices or systems for mortars. Many of the details of these will eventually appear as a part of our standard system. Among the devices which have so far been disregarded in our development, but which may sometime be incorporated in our system, should be mentioned the semi-automatic sight and the mechanical range and deflection corrector device.

The plotting board has been developed into a fire commander's board, with pantograph attachment for any baseline, and into the 360° type for mortars, but is still in use for rifle batteries in nearly its original form.

The above comments bring the system nearly up to the present date. It is hardly valuable to list the present standard system in its details, as this article is for the benefit of those who are all familiar with it on account of daily use. In the near future, we may expect slight modifications in the system in order to make possible more accurate correction for variations in the factors influencing the trajectory; while other modifications may be necessitated by the increased range of our guns with the new projectile, which will demand greater accuracy of position finding and more careful observation of atmospheric factors, with correction therefor. Then, too, there may be needed for batteries a form of plotting board which will render possible practically instantaneous shifting from one set of position finding stations to another, the communication system being arranged with the same object in view.

Acknowledging all the above, our system is efficient, trustworthy, and thoroughly admirable as it stands, and the Corps owes a debt of gratitude to the many officers whose earnest and efficient work has brought this essential part of our fighting system to so high a degree of efficiency.

It is desired to emphasize, in closing, the point brought

out at the beginning of this article, viz., that imperfections, errors, and omissions are very probably to be found in it, possibly in large numbers, and that it is most desirable that these should be exposed when found. It is hoped, therefore, that the JOURNAL may be in receipt of correspondence from all interested in the subject, in order that the facts may be collated and published in a later number by way of comment on or correction of this article.



# THE FAILURE OF THE 14-INCH GUN AT SANDY HOOK

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Immediately after the failure of the 14-inch gun under test at the proving ground on December 9, 1912, an eminent authority on gun construction in this country made a statement, which in concise form and untechnical language, covered the subject in so far as the facts were known at that time; but, although prepared with a view to allaying, through the daily press, the not unnatural disquietude in the public mind caused by the incident, only a few unimportant lines of the statement have found their way into print. The JOURNAL, therefore, takes this occasion to present to its readers the statement in full, notwithstanding that there are now available facts which were not known at the time the statement was made.

The gun was of the type known as the built-up construction, which was until recently standard in the United States Army, and is still standard in the United States Navy and with most foreign powers. Guns of this type are made of large cylindrical steel forgings which are assembled, one upon the other, by shrinkage. The theory of the design is considered sound, but its success depends upon such excellence of material in the large steel forgings employed as to require almost perfection. Until comparatively recently it has been considered that the method of manufacture of these forgings insured such practical perfection. The metal, a carefully selected mixture of iron products, is first melted under conditions of great particularity, and is cast into an ingot. This ingot is then reheated and is drawn out to greater length by forging in a heavy press. It is afterwards bored out, and again reheated and further elongated by forging, this time on a mandrel, which is passed through the central hole which has been bored out. By these processes the metal receives very severe working, and it has been considered that it was thereby so kneaded and consolidated that all bubbles, seams, and other defects were eliminated; especially as considerable portions of the ingot were cut off from both top and bottom, these being parts in which defects known as "pipes" and "blow-holes" would be most likely to accumulate.

Experience has, however, shown that these large forgings, although the finest steel products which are produced, cannot be absolutely relied upon. Accidental failures of guns have occurred, by bursting; and investigation has led to the conclusion that they have been due to defective material. In some cases, cracks have appeared in guns and have been discovered before the guns have burst, and subsequent separation of the parts, by cutting them apart, has disclosed the presence of theretofore unexpected flaws. Up to the present



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of the gun under test on December 9, 1912, does not obtain in the older types of built-up guns, but was incident to changes made for the purpose of decreasing the cross strains in the jacket at the rear end of the tube and for the purpose of securing higher physical qualities in the threads in engagement with those of the breech block.

3. The feature of design to which the failure is attributed is peculiar to only four guns, of which two had been previously subjected to proof firing without showing any signs of weakness.

4. By the failure, the jacket was the only part of the gun proper which was destroyed.

5. Measurements of the tube and other remaining parts of the gun indicate that they have not been injured by the destruction of the jacket, and that the gun can be repaired at a moderate expense.

6. It is practicable to modify the design to remove the suspected weakness, and all four guns of the type will be altered accordingly and then subjected to proof firings before being issued to the service.

7. The modification of design consists, essentially, in cutting off a few inches from the rear end of the gun to remove the weakened section, and in substituting a new type of breech bushing.

8. In addition to their negation through attributing the failure to a defect in design, abnormal behavior of the powder, failure of the gas-check pad, and flaws or defects in the fractured metal, are believed to have been disproved positively as well.

Nearly coincident with the accident at Sandy Hook came news from England of the bursting of a 13½-inch gun at Shoeburyness; and though it was generally stated in the English journals that the gun was of the wire-wrapped type, neither the cause of the explosion nor the precise nature of the damage was given out for publication by the War Office. One writer in an English publication, however, has stated that the accident was due to the bursting, for some unknown cause, of a high explosive shell when about half way along the bore.

More recently there has occurred at the experimental ground at Shoeburyness an explosion of an 18-pounder gun; and through published reports of this accident it becomes known that there were fatalities attendant upon both it and the bursting of the 13½-inch gun, which emphasizes very markedly the contrast between the reportorial sensation in the United States incident to a mere failure of a gun under proof and the journal-

istic restraint in Great Britain on the occurrence of two proving ground failures accompanied by loss of life.

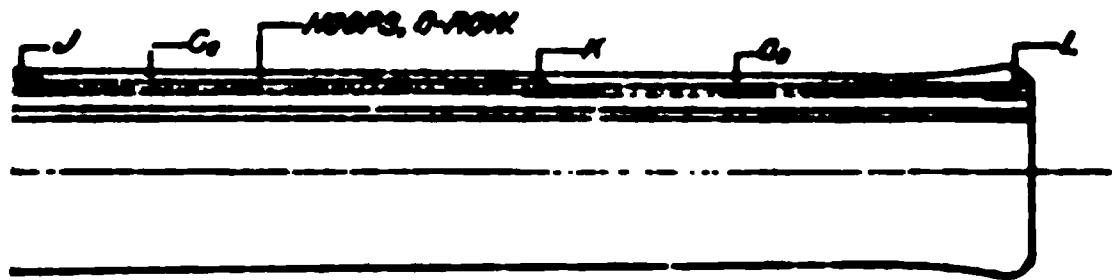
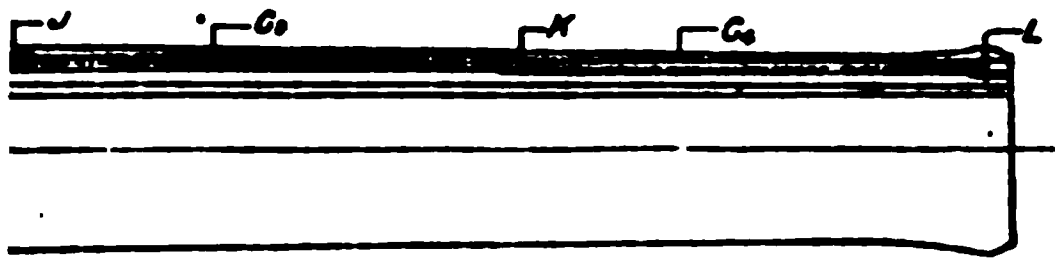
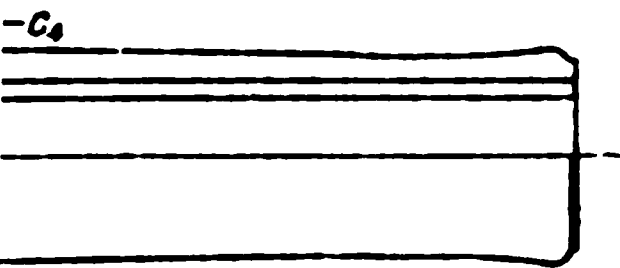
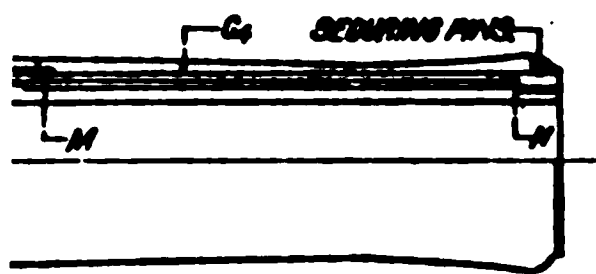
Interest having centered somewhat in the 14-inch gun by reason of the failure of one gun of one of the several types of that caliber, descriptions of the various types, with accompanying plate, are appended.

#### 14-INCH GUN, MODEL OF 1907

This gun is of the wire-wound type, and, except the wire, the breech bushing, and the A and N rings, the gun proper is of gun steel. The wire is of steel of high physical properties, while the breech bushing and the A and N rings are of forged steel "C". The gun is composed of a tube on which are shrunk the A, B, and N rings, the latter in addition being threaded on to the tube. The wire is first wound on the muzzle portion of the gun, the various rings being assembled during the operation of winding. The rings B, C, D, E, F, and G serve as a means of locking the tube and jacket together. The jacket is also secured against movement in the opposite direction by means of a breech bushing screwed into the breech of the jacket and resting against the end of the tube. These rings are used for the purpose of securing a means of beginning and ending each wired section. Each section is made up of a continuous length of wire. The different spools of wire are brazed together with a silver flux between a scarf joint. The H, J, L, M, and N rings are also used as terminating points of the several muzzle hoops.

Upon the breech portion of the wire-wound construction is assembled the jacket, the rear fourteen inches of which extends beyond the tube and serves as a seat for the breech bushing. Forward of the jacket are assembled successively the C-1, C-2, C-3, and C-4 hoops. The forward, or C-4, hoop is locked to the N threaded ring by four steel pins ninety degrees apart. The wire used in this construction is of one-eighth inch square cross-section. It is wound on the breech at a tension of 46,500 pounds per square inch. Upon the jacket and over the center of gravity of the gun is assembled the trunnion hoop, which has a total finished length of thirty-two inches. The trunnion hoop is locked to the jacket by means of two shoulders of different heights. The breech bushing is screwed into the extreme fourteen inches of the jacket which overhangs the tube. It is prevented from rotating by a hinge (not shown on plate) which is milled into the face of the gun and bushing. The

rtillery, March-April, 1913. To face page 194.





breech bushing is threaded and sectored to correspond to the block.

#### THE 14-INCH GUN, MODEL OF 1907, MI

This gun is of the built-up type, being of solid gun steel construction except the breech bushing, which is of forged steel "C." It is composed of a tube the length of which is 481 inches. Upon the tube are assembled the C-1, C-2, C-3, and C-4 hoops, the latter being locked to the tube by means of shoulders. With the exception of the C-4 hoop, these are assembled in succession, the C-4 hoop being the last except the trunnion hoop to be assembled to the gun. Upon the C-1 hoop and extending partly over the C-2 hoop is assembled the A-1 hoop. The A-1 hoop is locked to the adjoining parts by means of shoulders and the breech bushing. Upon the A-1 hoop is next assembled the B-1 hoop, the rear fourteen inches of which serves as a seat for the breech bushing, which is threaded in it. This hoop is locked to the A-1 hoop by means of a shoulder and by breech bushing. The D-1 hoop is next assembled and locked to the A-1 hoop by means of a locking recess. The D-2 hoop is next assembled, locking together the C-2 and the C-3 hoops, followed by the assembling of the C-4 hoop, which is locked to the tube and the C-3 hoop by means of shoulders.

The trunnion hoop is last assembled. It is locked to the B-1 hoop by means of two shoulders of different heights. The breech bushing is made of forged steel "C" and screws in the overhang of the B-1 hoop. It is prevented from rotating by the hinge in the same manner as in the 14-inch gun, model of 1907. It is threaded and sectored to correspond to the breech-block.

#### 14-INCH GUN, MODEL OF 1909

This gun is of the wire-wound construction and similar in that respect to the 14-inch type, model of 1907.

The gun is composed of two tubes, A and B, each 565 inches in length. The purpose of these two tubes is to limit the extension of thermal cracks in the bore to the inner, or A, tube. These tubes are first assembled with only a moderate shrinkage, having one shoulder one quarter inch high located at a point one hundred inches from the breech end of the tubes. The gun is constructed wholly of gun steel, except the spool and step rings, the breech bushing, and the wire. These rings and the breech bushing are of forged steel "C," and the wire has very

high physical properties. Upon the assembled tubes the A, C, and L rings are shrunk, the latter in addition being threaded to the outer tube. This construction is in every respect similar to the one described for the 14-inch gun, model of 1907. Upon the breech end of the wire covered tubes is assembled the jacket, which extends beyond the end of the tubes fourteen inches to serve as a recess for the threaded breech bushing. In order to lock the C-1 hoop and the jacket together, a locking hoop is provided engaging them by means of shoulders. The assembling of the C-2, C-3, and C-4 hoops follows. The C-4 hoop is secured to the muzzle L ring by eight securing screws. This type of gun is intended for a barbette mount, no trunnions being provided. For guiding the gun in its sleeve, a forged steel key 72 inches in length is sunk in the top element of the gun and secured by five steel screws.

#### 14-INCH GUN, MODEL OF 1910

Except for the method of mounting, this type of gun is similar to the model of 1909. A description of it is therefore unnecessary. The type is arranged for mounting on a disappearing carriage and the trunnion hoop serves the purpose of the locking hoop of the 1909 type, obviating its use, since the trunnion hoop locks the jacket to its forward hoop. There are other slight differences, mainly in the diametral dimensions, as for instance, the maximum exterior diameter of the jacket of the 1909 type is 1.7 inches larger than the corresponding dimension of the 1910 type.

# PROTECTED OBSERVATION POSITIONS FOR ARTILLERY ON THE BATTLE-FIELD

BY LIEUTENANT-COLONEL F. ANDERSEN, OF THE NORWEGIAN ARMY

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The latest wars, especially the war between Russia and Japan,\* offer to careful observers many reasons for believing that the present-day weapons of warfare necessitate so great an alteration in the principles of carrying on war that it might almost be said that we are on the eve of a complete revolution in the matter. Indeed, it may be assumed that every state will very soon be occupied with peace exercises in preparatory organization and other similar work, the necessity having been still further emphasized by the latest development, by which aviation has been added to all previously known means of obtaining and communicating intelligence.

The tremendous power of modern fire-arms, their quick-fire, precision, and great range, demand that they shall be utilized in a manner entirely different from that with which we have hitherto been satisfied. For that manner of utilizing artillery was the outcome of methods of aiming and correcting in which practically everything depended on the coolness and presence of mind displayed by the gun-officer and his men at their posts, generally amidst the greatest heat and tumult of battle, of which one result was a suprisingly small percentage of hits out of the number of shots fired. Sometimes the guns were employed in exposed positions where such exposure was not required. At other times the artillery was not brought into action at all where good use could have been made of it; for example, in the actions during the Japanese advance against Port Arthur's east front.

In the title of this article I have tried to suggest in what the aforesaid revolution of the present-day methods of warfare will consist; for I believe that the development of modern fire-arms in combination with the latest auxiliaries, among which the aeroplane is perhaps the most important, will necessitate

\* See Appendix.



a far wider application of earlier known expedients, such as reconnaissance-sketching, mapping, telephony, telegraphy, wireless telegraphy, etc., for directing the fire of the artillery, especially of the heavy pieces, from the terrain in front of the guns; that is, from points which I shall call "protected observation positions." These positions must be so situated that it will be possible, not only to make the necessary observations for directing the fire, but also to communicate the results thereof with certainty and expedition to the batteries in rear. In this way, not only will the effective range of the fire be far more extended, but the whole direction of the operations, both in the battery positions themselves and in the "protected observation positions," will proceed with much more steadiness and precision.

I will not enter into any closer particularization of the different modes of proceeding, the details of which may vary in manifold ways, but shall merely mention that it should be well known that there are enough practicable methods for directing the fire even with the use of quite simple expedients. Neither will I discuss nor recommend any of the automatic devices for directing the fire, as I am aware that none of those hitherto invented are serviceable in practice. I will merely remark that, if in addition to all the present expedients there should come in the future a serviceable automatic appliance for directing the fire from a distance, it would be of enormous importance.

The terrain against which the fire is to be directed will be divided into spheres of observation, and observation-troops will be distributed for the occupation of the above mentioned observation-positions. These observation-troops are to be posted so that they can observe all the ground over which the enemy may possibly advance within range of the artillery behind. This artillery, which I shall call the *main artillery*, will be of a special class with large caliber. The necessity for its presence rests upon the fact that it will be necessary for this artillery to extend its area of fire as far as possible to the front of the above-named "protected observation positions," in order to cover all important approaches, bridges, roads, and cross-roads, as well as the enemy's advanced posts, etc. The more accurate this fire and the greater its range, the more effective will it be in the decision of a battle. Range and effect will, therefore, be the determining factors in the choice of caliber.

ility, it is true, has its importance; but great decisive events, no less in the future than in the past, will be fought

on ground where roads and other means of communication are to be found, and there will be comparative freedom in the choice of positions for the artillery. In addition, we have the new machinery which is now available for increasing mobility, so that it will certainly be possible to meet all requirements in this respect even for guns of quite large dimensions. This artillery, on account of the much more comprehensive task demanded of it, is not to be compared with the "position artillery" formerly used.

The mobile army of the future will certainly in important campaigns employ *main artillery* up to the largest caliber. But, in general, with massed batteries, the main artillery may be assumed to have a caliber of from 12 to 15 cm. This artillery will have a range from 3000 to 4000 meters greater than that of the field-pieces and can thus perform its task of covering the terrain in front of the latter, so that these two kinds of ordnance may mutually protect and promote each other's work.

The observation-troops are to be so organized and are to be in such strength that they can not only reconnoitre and maintain communication with the main artillery in their rear, but also maintain and defend their positions and at favorable moments in the battle even take the offensive; for example, when reserves are moving forward to points in the field of action selected for a vigorous advance movement. Hence, their strength must be adapted to the extent and importance of the task they have to perform. The force may consist of large units of troops with a general officer and staff, and may include all arms, according as circumstances dictate. The "protected observation-positions" will be, therefore, the actual fighting positions.

In the choice of a station for the main artillery, there will be comparative freedom. There must be no hills in front of the battery so high or so adjacent as to impede the fire. The position for the guns must not be capable of being overlooked from the enemy's side. The site may be either high or low, as desired. A position not too far from roads is to be preferred, but neither should it be too near to roads or other easily observable landmarks, which might facilitate the enemy's observations. Low scrub affording good concealment would seem to constitute a favorable position.

How can the necessary knowledge of the terrain against which the fire is to be directed be secured, so that it may be possible to direct the fire with certainty? It is just here that

the key, as it were, to the enemy's position lies in the able leader's hand. For he must by means of scouts, reconnoitring parties, etc. (spies are not to be contemned), put himself in a position to judge correctly of the conditions; and then, on the basis of the knowledge thus gained, he will have a final effective resource in well-calculated reconnaissances in force. These are to be carried out by men specially selected and trained for the duty, accompanied by fearless riders, cyclists, chauffeurs with their automobiles, etc., and even aviators in their aeroplanes.

If a leader in war does not keep his eyes open for all opportunities afforded by circumstance, many chances of being able to direct the fire effectively will be lost. It will also be very unfortunate if the authorities in peace time do not by means of suitable administrative measures make sure of having the means, both of men and equipment, necessary for applying in war the above mentioned principles; for, if they do not, their army though otherwise superior in equipment and numerically larger will, in all probability, be vanquished by its adversary. Indeed, it is obvious that through neglect of such means a whole campaign may easily be a lost game from the very outset.

The accuracy with which the actual directing of the fire from a distance can be carried out depends, however, first and foremost on the skill of the observation troops in judging the nature of the terrain, and on their thorough knowledge of their work in the field. With a view to this they should be specially trained to make sketches of important sections of country in great haste, at the same time including in them everything necessary for the direction of the fire, and preparing them on a scale adapted to their purpose.

No reasonable requirements, however, in this respect should fail to be met, under normal conditions, with competent leaders who have a proper grasp of the problem here discussed; for they can arrange for the necessary training and give it life and interest.

As regards the more general requirements in the application of the system above described, the following points must be noted:

Nowadays, in almost every terrain where we can at all imagine a battle on a large scale's taking place, we shall always find a more or less complete network of telephone and telegraph connections. And it will be the business of the observation troops to be prepared to utilize these connections in the best possible manner for the object they have in view. Even when

Advancing into the enemy's country, serviceable material ought often to be found at hand, as it will certainly be very seldom that an enemy will be able to remove or destroy all such material.

Nevertheless, it will be necessary to take along as large a supply as possible of telegraph wire and like material. In the vicinity of fortified places there will, as a rule, be found a network of telephone and telegraph connections, which can, to much advantage and without any great loss of time, be turned to account for the system here described.

There must be at all times the closest cooperation between the actual observing parties and that portion of the observation troops which is employed in the general duties of occupying and guarding positions. Amongst the present-day demands in the matter of cooperation between the different sections of a large army, must be reckoned the communication from one section to another of everything that one can learn about the enemy's dispositions and the like which it might be useful for the other to know. But here that demand is greatly emphasized, for the observing troops must be put in possession of all possible information that can lead to the enemy's being brought under fire as soon as he comes within the sphere of observation.

In the next place, it must be clearly understood that all sections are to cooperate to protect the observation service, so that the latter may carry out its task while maintaining effective communication with the main artillery. Indeed, the tactical import of "protected observation positions" will find expression in modern warfare only in case there is perfect cooperation between the artillery and the other arms in and around these positions. It will be especially the artillery on the one hand, the lighter caliber guns of which can be employed more directly in connection with these positions, and the infantry on the other, which will here support and complete each other's work. But the principle holds good also for the cavalry, as well as for the engineers and other arms.

Even though in the latest wars there may not have been fully developed much regarding the direction of fire from advanced positions, still there are not lacking in the main events indications which clearly enough point the way in the matter. Port Arthur's east front has already been mentioned above. If the Russians, on the approach of the Japanese, had there employed advanced "protected observation positions" and thereby extended the actual fighting line farther to the east,

and at the same time had employed their heavy guns in conformity with such disposition, it is difficult to imagine that they could have failed to achieve success. In Manchuria we have seen how concealed positions for the artillery were more and more adopted, and how cooperation between the artillery and the infantry developed itself in that peculiar manner which results from the pressure of actual events.

Regarding the relative advantages of defending and attacking forces, the following points may be noted. As the defending force will always find it easier to make use of guns of heavy caliber than the attacking army, it will apparently have an advantage in that respect. But there is no doubt that heavy ordnance will come to be of predominating importance for the offensive, in as much as it will be employed to search the terrain far in advance of the army, its employment representing a vigorous and definitely directed forward movement. The main artillery will thus be the working factor in producing and directing an effective attack, while the lighter batteries with the infantry and others arms will come to utilize and drive home that attack.

It would lead us too far to go into details of execution, but I must mention, on the one hand, the necessity for a thorough-going system both in organization and in the formulation of plans, if the object here aimed at is to be attained, and, on the other hand, the enormous advantages which the attainment of that object will entail, not only directly for tactical ends, but also indirectly through those for strategical purposes.

#### APPENDIX

##### I. REPORT BY LIEUTENANT COLONEL C. V. HUME, D. S. O., ROYAL ARTILLERY,

TOKIO, 30TH MAY, 1905.

33. *Some tactical points.*—I submit some tactical remarks based on observations made and information received during this and former battles:—

(1) With the increase in the power of field guns has come increased caution on the part of artillery commanders, involving an extensive, I may say invariable, use of artificial cover, and a tendency to begin engaging the enemy's guns at long or even distant ranges with consequently indecisive results. This last is a dangerous tendency, as subsequent advances and changes of position are, as a rule, impossible by daylight.

(2) Infantry treats shrapnel with great respect, and seldom gives the opponent's guns the chance of a good target. Moreover, field artillery can produce little or no effect on infantry in good trenches beyond making the men keep their heads down. Except on a few special occasions, therefore, the casualties caused by artillery fire have been very small. But its moral effect is great and though it is the fashion for certain hard-fighting infantry regiments to abuse the artillery, and affect contempt for its support, the great majority of infantry commanders look more and more for the support of the guns during an attack. One brigade commander told me he liked the artillery to keep on firing till the very last moment, in spite of any losses it might cause him, while another, to emphasize his point, averred that as long as the artillery kept up their fire he didn't mind if they knocked over a third of his men! I have heard of other instances of infantry commanders sending back to request that the guns would go on firing, and of artillery commanders receiving requests to concentrate their fire on some particular point, or on some specially destructive machine guns.

(3) To bring guns into position, or to change position, in the open, under artillery fire, is nowadays to court disaster. In the attack, therefore, the precedent set in this campaign will generally have to be followed, *i.e.*, batteries will be put into prepared positions under cover of darkness, and will open fire at daylight. A mistake in the selection of a position in open country will not be rectifiable till the following night, so that care in the selection of positions becomes all-important. Not only must they be chosen with reference to the enemy's guns, but also with a view to supporting the advance of the infantry when it shall take place.

(4) If the teaching of this war is to go for anything, it has so far proved that the complete artillery preparation introduced by the Germans in 1870 as a preliminary to the infantry attack, is no longer the absolute necessity we, in common with continental nations, consider it to be. In the first place, except under the most favorable conditions of ground, or with very great superiority in number or power of guns, it is practically impossible to silence an opponent's artillery if it be well entrenched. In the first fight of the war, the battle of the Ya-lu, fought by the First Army, the Japanese did everything according to the letter of the drill book, and, with a vastly superior artillery, spent a whole day in an artillery preparation



which was most complete and efficacious. On this occasion it may, however, be remembered that the Russian guns were very badly handled, and very few of them were entrenched, so that everything was in General Kuroki's favor. Since then the artillery has never been strong enough to silence the Russian guns, and the Japanese, recognizing this, having accepted the situation and launched their infantry without waiting for the result of the artillery duel, I am quite prepared to admit that the Japanese infantry has suffered more losses than it would have had its artillery been strong enough to thoroughly prepare its attack, but the proof of the pudding is in the eating, and the fact remains that the Japanese have won all their battles. What I want, therefore, to point out is that it is dangerous to allow such sentences as the following to remain in our "Combined Training"—"it should be clearly understood by all commanders that no further advance\* should be made until the artillery preparation is complete,"—Section 18, paragraph 3.† Had the Japanese adhered to these principles, very few infantry attacks would ever have been delivered, and I have often wondered why our writers on tactics should assume that British artillery in the attack will always be able to silence the defender's guns, and will then always be able to turn its attention to his infantry and to the points to be attacked, and that then only will the infantry be able to advance to the final attack and assault. They prescribe no course of action to be followed in case the above programme cannot be carried out, and they leave it to be inferred that the only alternative is to abandon the attack. Owing to the inferiority of the French artillery in 1870, the Germans were generally able to go through with the programme in question, and so it has come to be regarded by Europe as a necessary preliminary to a successful infantry attack.

I do not agree with some critics who say now that the artillery duel and preparation have ceased to exist as a separate phase of the combat. I think opportunities will occur, as at the Ya-lu, when they can be carried out in their entirety, and on such occasions the procedure laid down should be closely followed. But what I do believe is that when the opposing artilleries are fairly well matched such opportunities will be rare, and that when the artillery of the attacker is inferior in quality to that of the defender, the former must invariably be

\* "*i. e.*, from positions within effective range of the defender's lines,—C. H. V."

† "Lieutenant-Colonel Hume is quoting from the 1902 edition; there is nothing of the kind in the 1905 edition, *see* Section 118."

prepared to launch his infantry against a position without waiting for the result of the artillery preparation. All he can then hope to do with his artillery is to engage the attention of the defender's guns to a greater or less extent. This is the present attitude of the Japanese *vis-a-vis* the Russians. One senior officer, a colonel of Japanese artillery, gave it to me as his opinion that the infantry must be always ready to attack directly the artillery has got its ranges; it was hopeless to wait till the artillery had established its superiority, as guns were never knocked out nowadays.

\* \* \* \* \*

With reference to this question an artillery staff officer gave me his opinion as follows:—"In the country we have been working in, our duels have been across broad valleys, and therefore with long ranges. We could not go further down into the valleys than we have done, as we should have exposed our guns and been obliged to fire too much up hill. Therefore the duels have been indecisive. Without *great* superiority of guns one cannot silence those of the enemy. Therefore infantry must attack without waiting for the result of the artillery fight. Then, if our artillery is strong enough to engage the whole attention of the enemy's guns, our infantry is comparatively safe. Also, as in the last battle, if the enemy puts his guns into hidden positions, the infantry can get on all right, as the guns cannot reach them with their fire." What he said about ranges was quite true. The ranges at which the artillery of the First Army has opened fire have generally been dictated by the formation of the hills and the breadth of the valleys, and though the Japanese artillery cannot be acquitted of the charge of over-caution, I do not agree with the somewhat sweeping criticism passed on it by some of the foreign onlookers and even by its own infantry. As regards the difficulty of silencing guns, I would refer to paragraph 4 of this report, from which it would be seen that it took the Japanese two days to establish their superiority along the section of front in question, although they had double as many guns as the Russians. On the following day however (28th February), twenty-four Japanese field guns and four 15-cm. howitzers silenced twelve Russian field guns after an hour's duel. The Russian gunners fought gallantly and continued firing for ten minutes with only two or three guns. Many of them were killed and the Japanese could see them being replaced.



Another reason why infantry must nowadays be prepared to attack without due artillery preparation comes from the enormous length of the modern battle-front. The success or failure of any particular division may make it necessary that the neighboring division or divisions should be suddenly launched on an attack without reference to the state of its artillery fighting. Similarly, a division of the flank of an army may have to make a wide turning movement, the distance it has to cover making it necessary that the movement should be initiated before the artillery duel has even begun.

(5) As I have remarked, to maneuver guns in the open under hostile artillery fire is to court disaster. The artillery of both sides has been most careful not to expose itself needlessly, and the instances that have come under my notice where it has had to do so have been but few. They are not, therefore, convincing; but such as they are, they hardly tend to show that the movement of batteries or brigades, as a whole, as recommended in our "Field Artillery Training," is a feasible operation, though theoretically it is the thing to do. Rather should guns be moved singly. At the battle of Ya-lu, it will be remembered that a Russian battery which exposed itself on the move was overwhelmed by the Japanese guns, and had to be abandoned. Again in this last battle a half battery of Russian guns, moving as a whole, was brought to a standstill and captured (see paragraph 23 of this report). On the other hand, a single gun on this latter occasion got safely away; while in the battle of the Sha Ho, two whole batteries moving gun by gun at long intervals, crossed a bit of shrapnel-swept open without dropping a man. This last incident I described in my former report on artillery. That occasions will occur when artillery must advance and willingly undergo losses is a tradition we cannot afford to dispense with, but the amount of caution to be mixed with the dash is an increasing quantity. The range, power, and accuracy of field artillery has, however, so much increased that, if attacking batteries choose their positions well to start with, they will probably not find it necessary to leave them till the pursuit begins.

(6) A remarkable feature of the artillery work in this war has been the extensive use made of artificial cover. Never during the year's fighting have I seen a battery coming into action without first making epaulements or gun-pits, or at all events throwing up some cover for the detachments before opening fire. Not till the pursuit began, on the 8th March,

did artillery begin to do without them, and then it rightly cast them aside whenever the occasion demanded.—*The Russo-Japanese War. Reports from British Officers attached to the Japanese Forces in the Field. Vol. II, pp. 616-620.*

II. REPORT BY LIEUTENANT COLONEL A. L. HALDANE,  
D. S. O., GENERAL STAFF,

TOKIO 15TH OCTOBER, 1905

*Cooperation of Artillery*

As mentioned, the nature of the battles in Manchuria resembles that of the attack and defense of a fortress, and as a consequence the Japanese artillery has generally been able to take up positions under cover of darkness in order to support an attack. The Russians generally disclose their own gun positions by firing upon the infantry from the first moment of the advance, expending most of their efforts against it. The effect of this fire when any cover is available may be judged from the fact that the Russians fired an average of 1000 shrapnel shells with a loss to the Japanese of only one man during the four days that elapsed immediately after the latter took up positions on the Sha Ho in October, 1904, when the defenses were of the slightest. Great vigilance is displayed by the Japanese artillery commanders in following the stages of the infantry attack, and though orders are generally sent to them prior to some new development thereof, it is rarely the case that they have not already been anticipated and arrangements made accordingly. Whenever possible enfilade fire is brought to bear upon the enemy, the guns of one division turning their attention temporarily to a flank when it is evident that a neighboring division will thereby be assisted and the general movement against the enemy furthered.—*The Russo-Japanese War. Reports from British Officers Attached to the Japanese Forces in the Field. Vol. II, p. 516.*

III. REPORT BY LIEUTENANT COLONEL C. V. HUME,  
D. S. O., ROYAL ARTILLERY,

TOKIO, 8TH JULY, 1905

11. The First Army lost about 10,000 officers and men, and captured about 5000 prisoners, exclusive of those who died in the Japanese hospitals. The *Japan Times* gave the losses of the First Army as follows:

	Officers.	Men.
Killed	71	1758
Wounded	284	8318
Missing	2	52
	<hr/> 375	<hr/> 10128

12. The heaviest losses were incurred by the Second and Third Armies, the former of which is reported to have lost 28,000. A member of Marshall Oyama's Staff put the Japanese losses during the battles down at 71,000.\*—*The Russo-Japanese War. Reports from British Officers Attached to the Japanese Forces in the Field. Vol. II, p. 252.*

IV. REPORT BY CAPTAIN D. S. ROBERTSON, ROYAL  
SCOTS FUSILIERS

TOKIO, 19TH JUNE, 1905.

*Frontal Attacks.*—The attacks made on the Russian defences from 4th to 8th March support the theory that frontal attacks across the open against an unshaken enemy are impracticable, unless entrenchments are constructed. Those attacks were undoubtedly made with the object of breaking through the line of defense of the Russians, and not merely to hold them in their trenches and cause them to reinforce the line at the expense of the other parts of the defense. It was not due to an employment of an insufficient number of troops that the attacks did not succeed, and the numbers of dead lying on the battlefield, more especially on the right of the 8th Division, where the 42nd Regiment of the 5th Division had about fifty men per company killed in the attack on Sha-to-tzu, prove that men have not been spared in making the attacks. The failure seems due to the fact that the task was an impossible one unless either pressure on a flank caused the defending troops to retire, or a concentrated artillery fire prevented them from using their rifles at the critical moment when the Japanese infantry made their assault, or the attacking troops were able to entrench themselves in a position at decisive range where they could bring up reinforcements to overwhelm the enemy with superior fire. The success of former frontal attacks made by the Japanese is probably due to one or other of these reasons, but, as

\* "The latest reports put the Japanese losses at 71,014; in round numbers: First Army 10,000, Second Army 22,000, Third Army 18,000, Fourth Army 13,000, Ya-lu Army 6000."

noted before, none of these advantages was on the side of the 8th Division in its attacks on Yang-shih-tun and Kan-kuan-tun. The Russian line opposite the division was continuous, so that pressure could not be brought to bear on a flank; the exact position of the trenches and redoubts was not discovered, so that the artillery fire had little effect on the Russian troops defending them; while entrenching was not possible.—*The Russo-Japanese War. Reports from British Officers Attached to the Japanese Forces in the Field* Vol. II. p. 212.

The conclusion to be drawn from the reports quoted is obvious: the Japanese infantry in particular and the Japanese troops in general were obliged to pay with enormous loss of life for the failure to utilize the artillery and to adapt it to the demands of the moment. There is here a huge gulf to be filled up between what is now offered and what is required.

The duty of the artillery is not alone what is demanded of soldiers in general, namely, patriotic fervor, calm contempt for death etc.; but in addition, the exertion of every effort to utilize scientifically such material and auxiliaries as it may have.



# COAST DEFENSE IN THE CIVIL WAR\*

## FORT DONELSON, TENNESSEE†

BY 1ST LIEUT. WALTER J. BUTTGENBACH, COAST ARTILLERY CORPS

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### GENERAL SITUATION

In view of the success achieved in the capture of Fort Henry, February 6th and 7th, Fort Donelson became the next objective; for, by its capture, the Federal forces would get control of the Cumberland, opening the way to Nashville and effectively breaking the Confederate line from Columbus to Bowling Green.

### SPECIAL SITUATION

The attack on Fort Donelson was proposed by General Grant in reporting to General Halleck the surrender of Fort Henry. In his report of February 6th he stated that he intended to take Fort Donelson on the 8th.

### OPPOSING FORCES

#### CONFEDERATE

Fort Donelson was a bastioned earthwork of irregular trace, erected on a bluff on the west bank of the Cumberland River and about twelve miles southeast of Fort Henry. The site is between two creeks, its elevation being one hundred and twenty feet above the water. A bend in the river gave the fort command over the river as far as its armament could carry.

Its armament, including the water batteries, consisted of:

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\* See note to "Coast Defense in the Civil War, Fort Sumter, S. C., (First Attack)," in JOURNAL U. S. ARTILLERY, for March-April, 1912.

† Though not strictly an account of an operation in coast defense, this account of the attack on Fort Donelson is introduced at this point in the series of articles on "Coast Defense in the Civil War," in order to present in chronological order the accounts of operations of guns afloat against guns ashore that took place during that war.

- 10 32-pounders, of which two were old carronades,
- 1 columbiad, firing 128lbs. projectile,
- 1 8-inch howitzer,
- 1 128-pounder, rifled,
- 2 9-pounders.

On the slope of the ridge facing down stream, were excavated two water batteries having traverses between the guns. The lower battery, twenty feet above the river, was composed of:

- 1 10-inch columbiad,
- 8 32-pounders.

The upper battery was fifty feet above the river and contained,

- 1 rifled gun, 128-pounder,
- 2 32-pounders, carronades.

In the fort was a bombproof, which was connected with the batteries by a covered way.

The garrison comprised one hundred and fifty-five men and Ross' Light Battery.

Fort Donelson on January 18th, 1862, had the following ammunition on hand:

- 904 rounds, 32-pounder,
- 165     "     12-pounder,
- 100     "     10-inch columbiad,
- 250     "     12-pounder howitzer,
- 190     "     6-pounder.

There was around the fort and about fourteen hundred yards from it, a convex line of infantry works of some two and a half miles extent, interrupted at intervals. The works consisted of rifle pits (simple trenches with earth thrown up toward the front), and provision for the guns of eight field batteries to be distributed in nine positions about the perimeter.

The Confederate force, increased by the troops retiring from Fort Henry, was about six thousand men; but more troops were rushed in, so that on the night of February 12th the total field force defending Fort Donelson and its lines, was about twenty thousand men, or twenty-eight regiments of infantry, six batteries of artillery, and one regiment of cavalry.

The guns of the water batteries mentioned above, were mostly manned by men from light batteries and from the infantry, drilled as artillery.

## FEDERAL

Under Flag-Officer Foote the Navy was represented by the *Saint Louis* (flagship), the *Carondelet*, the *Louisville*, and the *Pittsburgh*, all iron-clad and each armed with thirteen guns, and by the *Tyler* and the *Conestoga*, wooden gunboats.

The Federal army under Grant consisted, at the beginning of the battle, of three divisions, or about twenty-five regiments of infantry, eight field batteries, and some cavalry, an approximate total of fifteen thousand; but later it was strengthened to about twenty-seven thousand. Five or six thousand of the total given were employed in guarding trains at the rear.

## NARRATIVE OF EVENTS

On February 7th, 1862, Federal cavalry, pushed out from Fort Henry, gained contact with the Condeferate outposts on the lines about Fort Donelson.

On February 11th, 1862, Flag-Officer Foote sailed with gunboats and transports from Cairo for Fort Donelson; and on the same day General Grant sent six regiments on transports down the river to follow the flotilla up the Cumberland. General Grant also brought together some fifteen thousand men at Dover, with eight field batteries, organized in two divisions.

The first division (McClelland's) moved up to Fort Donelson and encountered no opposition till it struck the pickets in front of the fort. The advance came in sight of the fort, on the south, about noon of the 12th of February.

The other division (Smith's) was moving on the line of infantry works, on the west of the fort.

Thus on the morning of the 13th, there were fifteen thousand Federals confronting twenty thousand Confederates, well intrenched; and, so far, the fleet had not appeared.

During this morning, the *Carondelet* came in sight and fired at the water batteries at long range, one shot striking a 32-pounder and disabling it.

A shot from the rifled gun of the fort struck the *Carondelet*, passing through a port-hole and damaging the machinery. The *Carondelet* thereupon withdrew out of range.

The flotilla, together with the transports, arrived that evening, the 13th; and the troops that came on the transports were landed, and with some others, were organized into a division and put in position to the right of Smith's division. That division was commanded by General Lew Wallace.

The 14th was spent by the Federals in moving up troops and in rearranging lines, shots being occasionally exchanged with the enemy.

The Confederates seeing themselves being surrounded, decided to try to cut their way out; but on account of the attack by the gunboats, which occurred in the afternoon, the movement was postponed till too late to be effected that day.

At 3:00 p.m., February 14th, Flag-Officer Foote moved up with his gunboats to attack the fort. The water battery attacked was a mere trench twenty feet wide, sunk in the hill side, with a rampart made of earth thrown outside, the parapet being about twelve feet thick at the top. Carefully laid sand bags added to the height of the rampart, spaces being left for the gun embrasures which, though narrow, were yet sufficient where the river channel itself was straight and narrow, requiring the fleet to advance in a straight line and with narrow front.

The gunboats, four ironclads and two wooden boats one thousand yards in rear of the ironclads, opened fire when a mile and a half from the fort and advanced slowly, firing rapidly till the ironclads were within four hundred yards of the batteries. The boats could use only their bow guns, three on each boat. The action had lasted an hour and a half, when a shot entered the pilot house of the flagship, the *Saint Louis*, then three hundred and fifty yards from the fort, and carried away the wheel. Also, the tiller ropes of the *Louisville* were disabled. Both these boats then became unmanageable and drifted down the river; and since the other two boats were likewise severely damaged, the whole fleet withdrew.

At the time of the fleet's withdrawal, Flag-Officer Foote reports, the Confederates were leaving the water batteries; so, had this action lasted a little longer, he could have hoped to take the fort, as the fleet had done at Fort Henry. But on this occasion the fleet was repulsed with heavy casualties.

On the 15th the Confederates finally arranged to make a sortie against McClernand's division, on the extreme left of the intrenchments, and a general battle ensued, the Confederates being finally driven back into their works about nightfall, disappointed in their attempt to cut through.

General Smith made an attempt on the right of the Confederate position, and was also successful.

Generals Floyd and Pillow transferred, in turn, command of the fort to General Buckner, who accepted it; while Floyd, with four Virginia regiments, nine hundred and eighty-six men,



his own troops, got away about daylight of the 16th, taking transportation that had just brought some four hundred raw troops to the fort.

General Buckner, on the morning of Sunday the 16th, capitulated, surrendering the works with some twenty-five guns and thirteen to fifteen thousand troops. About five thousand Confederates are said to have gotten away through the forest, during the night and day.

Thus the defensive line of the Confederates from Columbus to Bowling Green was broken, and the work begun in the capture of Fort Henry was completed. The Mississippi River was cleared down to Island Number Ten, where the Confederate line now was.

In this account, no attempt has been made to cover the land fighting about Fort Donelson, only salient points being mentioned in order to afford an understanding of the general situation in so far as it affected the fort.

The *Carondelet*, on the first day, February 12th, having preceded the flotilla, is said to have fired ten shells into the fort as a signal to General Grant of her arrival. The fort did not reply. On the 13th the *Carondelet* advanced to the attack at 9:05 a. m., and fired one hundred and thirty-nine 70-pounder and 64-pounder shots into the fort. The fort returned the fire and struck the boat twice, disabling its machinery, and wounding several men. The boat drew off at 11:30 a. m., but resumed action again at 12:15 p. m., bombarding the fort till dusk. On this occasion she fired some forty-five shots, expending nearly all the 10-inch and 15-inch shells. She sustained but little damage.

At 3:00 p. m. on the 14th, the flotilla engaged the fort, the action lasting till about 4:30 p. m. In this action the *Carondelet* had one gun burst, so had only two left in action. She was struck thirty-five times, the total casualties being five killed and twenty-eight wounded.

The *Saint Louis* was hit fifty-nine times, having two killed and eight wounded.

The *Louisville* was hit about half as many times as the *Saint Louis* and had four men killed and five wounded.

The *Pittsburgh* fired one hundred and five shells and six rounds of grape. She sustained thirty hits, four doing considerable damage. However, she had no men killed and only two wounded.

Few other details are given, though all the boats are known

to have been severely handled by the shore guns, the action being stopped by the *Saint Louis* and the *Louisville* becoming unmanageable. The fleet had in all fifty-four men killed and wounded. It is estimated that the Navy fired some two thousand projectiles into the fort and works.

Of the guns in the fort, nine only were effective, and of these only two, the columbiad and the rifled gun, were capable of use at ranges greater than twelve hundred yards.

The columbiad was fired twenty-seven times, and the 32-pounders forty-five to fifty times each. The number of shots fired from the rifled gun is not known. The rifled gun became unserviceable on the 14th, due to bending of the priming wire. The personnel serving this gun had had only two days' experience.

The success of the shore guns was due largely to the position of the batteries, rising as they did successively from the river to a height of fifty feet, enabling the guns to throw shot by a plunging fire into the holds of the boats, reaching and crippling their machinery.

The pounding of the flotilla's heavy guns inflicted but little damage in the fort—some embrasures were smashed up and one gun was disabled.

The casualties in the fort were two men killed and five wounded.

The fire of the boats was said to be more effective at two miles than at two hundred yards, for at this latter range the boats shot over.

The boats are variously reported to have approached the fort as close as four hundred, three hundred, two hundred, or one hundred and fifty yards.

#### COMMENTS

1. Another example of a fort and its works being surrendered, although itself successful in beating off a naval attack, because the field forces covering it were compelled to surrender.

2. The flotilla gave up its advantage of greater range of guns by closing in on the fort, thereby making useful the smaller guns on land.

3. The head-on tactics, so successful at Fort Henry, failed at Fort Donelson.

4. An adequate supply of ammunition enabled the fort to hold out.

5. The difficulty of hitting works situated on high sites was illustrated.

## AUTHORITIES

Official Records of the Union and Confederate Armies, Series I, Vol. VII, pages 157-416.

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JOURNAL UNITED STATES ARTILLERY  
PRIZE ESSAY COMPETITION

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AWARD OF 1912

FIRST PRIZE, one hundred dollars and five years' subscription to the JOURNAL OF THE UNITED STATES ARTILLERY, to  
CAPTAIN PAUL D. BUNKER, COAST ARTILLERY CORPS.

*Subject: What is the best type of projectile for the existing armament of United States seacoast fortifications?*

SECOND PRIZE, Seventy-five dollars and three years' subscription to the JOURNAL OF THE UNITED STATES ARTILLERY, to  
CAPTAIN LUCIAN B. MOODY, ORDNANCE DEPARTMENT.

*Subject: [The same as that of the essay to which the First Prize was awarded.]*

FIRST HONORABLE MENTION to

SECOND LIEUTENANT DOUGLAS C. CORDINER, C. A. C.

*Subject: [The same as that of the essay to which the First and the Second Prizes were awarded.]*

SECOND HONORABLE MENTION to

FIRST LIEUTENANT PHILIP S. GAGE, C. A. C.

*Subject: Discuss the principles involved in locating and siting gun and mortar batteries, submarine mines, and all accessories,—illustrating by a complete project of defense of a typical harbor.*

COMMITTEE OF AWARD

Colonel Frederick Marsh, Coast Artillery Corps,  
Colonel Millard F. Harmon, Coast Artillery Corps,  
Colonel Ira A. Haynes, Coast Artillery Corps.

*Publication of the essay to which the First Prize was awarded, has been unavoidably delayed till the May-June number.*



# PROFESSIONAL NOTES

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## THE INFLUENCE OF COAST FORTRESSES ON NAVAL STRATEGY

By Lieut. Colonel W. R. W. JAMES, Royal Artillery

From the commencement of my earliest efforts to study naval history I have, I believe rightly, endeavored to consider the subject in relation to my own special branch of the profession, and have been continuously met by the following difficulty.

Fixed armament firing over sea areas is commonly termed artillery for *Coast Defense*.

Modern naval historians take the utmost pains to elucidate these great principles, viz.:—

That the true *defense* of our island Kingdom, and of her outlying possessions, is dependent on the Navy; that invasion of the Mother Country, or annexation of territory beyond the sea, is an impossibility as long as our Navy remains unbeaten.

That the true naval objective of a belligerent is the adversary's naval force, and that until maritime preponderance, usually termed command of the sea, is obtained, transpontine land attacks are strategically unsound.

On the other hand when one turns to the plain narratives of our campaigns, ever since the beginning of modern history, one is confronted with the obvious fact that our naval operations have almost invariably centered round some *coast fortress*, in whatever quarter of the globe hostilities were conducted, even at periods when maritime preponderance was still in dispute.

One thus finds oneself on the horns of a dilemma.

Had strategists like Drake, Hood, or Nelson, not fully grasped the fundamental law governing the strategic use of their arm? It appears unthinkable.

Were they coerced into false strategical action by Governments unable to take a comprehensive grasp of the situation from the professional standpoint?

Written evidence in profusion is still extant in the national archives to negative such a suggestion.

Is the modern naval historian mistaken? Emphatically no.

The more time the student devotes to this all absorbing subject the more convinced he becomes of the basic truth of these maxims.

We seem, therefore, to be confronted with a problem worthy of the expenditure of all the time and brains that officers of the R. G. A. can devote to the solution; for, if there is no way of reconciling the existence of the coast fortress with what must be accepted as naval axioms, then every farthing expended on the maintenance of fixed defenses is money thrown away, and the coast defense gunner is condemned to a task only comparable to that of Sisyphus.

It is impossible for any thinking man to take a real interest in his profession, if, in his inmost soul there lurks a conviction that his labors are in vain, and that he is a mere cumberer of the ground; costly and useless.

### I.—THE UTILITY OF NAVAL BASES

I have on previous occasions essayed to prove by the light of history that coast fortresses were not without value; now I am attempting a further step.

My present object is to show that the maintenance of coast fortresses, erected for the purpose of defending naval bases, is not a transgression of any strategic law deduced from the operations of great naval commanders; but that the misconception as regards their utility has arisen owing to the fact that naval historians have generally failed to bring to notice their proper status as units in the setting of the strategic chess board. I attribute this mis-classification in a great measure to the generally loose use made of technical terms, such as *command of the sea*—*coast defense*—*raiding attacks*—*territorial invasion*, etc.; but also partly to the erroneous idea that complete maritime supremacy, without any ulterior object, can represent the objective of any true strategist.

#### THE VALUE OF COMMAND OF THE SEA

The possession of the sea itself is of little value.

The products that can be obtained from it, are not comparable to those of the land; nor can man support existence, or even venture on the ocean without the aid of the products of the land: he is a terrestrial, not a marine animal.

The value of the high sea rests on its utility as a highway, and not on its own intrinsic worth. When a nation has gained control of that highway, in order to coerce its adversary (which is the object of war), it must make use of the road; the mere possession of it, except as a threat, is of no advantage.

It is immaterial whether the possession is used to stop the enemy's supplies moving along it; to seize his goods, and thus reduce him to such a state of poverty that he is willing to make terms; or as a line of approach by which to attack him in his own territory.

The broad fact remains, *that possession of the sea is a weapon to be used*, and that its value lies in the use made of it.

In the case of Great Britain the issue has been confused because it is a truism that our very existence depends on our supremacy at sea; and yet the sea is only a road to us as to other nations. It is the land that produces the wealth that comes along the ocean path. The difference lies in the significant fact that for us there is no alternative road.

Supremacy at sea is all important to us on this account, and it is right to leave no stone unturned to impress this fact on the nation at large; but those who confound the means with the end are not doing their cause good, but harm. If the foundation is not sound, the building will not be durable.

This false doctrine is not a disease of modern growth, it was diagnosed by writers in the Elizabethan era, they recognized it as a dangerous heresy, classified it under the table of the "Idolatry of the Sea," and earnestly labored to counteract the mischief produced by it.

I mentioned the loose use of the term "command of the sea" as another stumbling block.

It is the custom to speak of the command of the sea as if it were usual for one or other belligerent to establish maritime preponderance throughout the

world, whereas this is a rare, almost unknown state of affairs. We did not possess it in the Revolutionary Wars for many years, nor did the North in the American War of Secession.

A ship has limitations owing to the fact that, although self-contained, she is not self-supporting; ultimately she depends on a base, and her power can only be exerted within her radius of action round that base.

In the era of sailing vessels this radius was defined by physical conditions, such as winds, currents, etc., which controlled the time it took to pass from one sphere to another; now the chief element is coal capacity; but in either case we arrive at the same condition of affairs; one belligerent may attain maritime preponderance in one sphere, and its adversary in another.

#### OBJECT OF ATTACKING A NAVAL BASE

I suggest that the following definitions indicate a road out of the apparent *impasse*.

(A)—An attack on a naval base is an operation of war directly designed to cripple a belligerent's naval force, either by:

1. Destruction of stores accumulated for the use of the fleet; or of docks, workshops, etc., required for the repair of damaged vessels, or
2. The capture of a "fleet in being" sheltering from the assailant's superior forces.

(B)—This object, whether actually carried out by land or sea, must be considered entirely apart from a hostile descent on territory from overseas with a view to carry out operations against an enemy's land forces, whether the objective of such a descent is simply to inflict damage, to create a diversion, or to conquer a country by invasion.

This is, I shall endeavor to show, by no means mere hairsplitting, but a real and vital difference; the first objective (defined in paragraph A above), distinctly appertaining to naval strategy, may be legitimate during the struggle for maritime preponderance in any area of operations; whilst the second, referred to in paragraph B, can have no direct bearing on this issue, and, if attempted, is unlikely to be attended with any success until the assailant has already attained maritime preponderance.

In making this claim for recognition of the fortified naval base as an integral part of our naval defenses, it is most essential not to fall into the error of overstating one's case; and above all not to slur over, or ignore, the arguments advanced by the other side.

We must take as our model not the persuasive eloquence of the advocate, but the balanced summing-up of an impartial judge.

It is worth observing that one of the most determined opponents of fixed defenses, Admiral Colomb, in his writings never appears to draw any distinction between naval bases and any other territorial possessions. To him the earth is strictly divided into land and water, and Gibraltar, Malta, or Portsmouth, represent to him only "spots of territory."

If, therefore, satisfactory answers can be found to the arguments of one, who must be acknowledged by all as an extremist, we may fairly claim to have established our proposition.

Admiral Colomb republished his "Essays on Naval Defense" in 1893. One of them contains a most vigorous onslaught on the opinions put forward in a paper read by Captain Stone before the Royal United Service Institution in 1889. Admiral Colomb commences his attack by this quotation from Captain Stone:



"My premise is that the possession of naval arsenals, dockyards, and coaling stations, must practically decide the question of naval supremacy, that such supremacy is absolutely essential to our existence as a nation, and that the way to secure it is to fortify and arm our own arsenals, dockyards, and coaling stations in such a fashion as to enable them to resist an enemy's attack, and at the same time to give a free hand to the Navy to attack those of the enemy with such force as may be available after providing for the patrolling of our principal trade routes."

Most people will agree that the Admiral had some reason to complain, and that the fortresses guarding naval bases have no such claim to prominence; and further that the primary objective of a belligerent is his adversary's fleet, and that a condition of affairs in which each fleet should be engaged in bombarding the other's base is unthinkable.

If, as Admiral Colomb tells us, the Navy laughed in its sleeve, perhaps it was not altogether without reason. But do not his own uncompromising opinions err as far on the other side?

It is not sufficient to expose the fallacy of the reasoning either of Captain Stone, or even of that upon which the Royal Commission of 1859-60 founded its demand for the strengthening of the naval bases. It is quite possible to come to a correct conclusion although your reasoning is based on erroneous data.

This is specially true when an old principle, accepted without question for generations, is suddenly challenged.

Because the fortifications of Portsmouth, Plymouth, and the Medway, will not prevent the invasion of England, it does not follow that they should be left without fixed defenses.

#### COMMUNICATIONS WITH A NAVAL BASE

Admiral Colomb's objections to fortification are based on the following arguments:—

"Spots of territory," whose water communications are kept open, are immune from attack, if their water communications are cut they must fail; this is true if we add "in time."

It is there that the whole crux of the question lies.

For what does Admiral Colomb mean by keeping the communications open? The only way to ensure that no hostile force passes between the fleet and its base is by marking down, and containing, every unit of the enemy.

Such a thing has never been done, and it seems unlikely that it ever will be as long as a belligerent has several bases open to him.

What we can and ought to ensure is, that no force should be able to maintain itself in such a position long enough to affect the conduct of our own operations.

The essence of successful warfare is to compel the enemy to conform to your own movements; how is this to be accomplished if, instead of being able to devote your whole energy to this end, you are hampered with the knowledge that, if a single unit intervenes between you and your unfortified base, all the material you depend on to continue the campaign is at his mercy?

The Commander-in-Chief of an Army in the field delegates the local defense of his lines of communication and base to subordinates, who, by judicious dispositions, and the employment of entrenchments, secure the supply of the main body against minor enterprises.

When we consider the intermittent communication with its base which is necessary for a navy, in comparison with the constant and uninterrupted flow of supplies vital to an army, and also the choice of roads between front and base open to the former, we see that the chances of success of naval operation against lines of communication increase as we approach the point of departure of the vessels conveying the stores. Not only is there less chance of evasion, but also the sphere of action is further from the main body. If the base stores themselves are equally open, then the greatest gain will accrue from making them the objective.

It may be argued that all this can be provided against by floating defense, and this is true enough provided you can be sure that you can calculate the exact force which can be brought against you, but the endeavor to do this will result in extravagant expenditure on local floating defense which is just as much an anathema to the blue water school as are fixed defenses.

I doubt whether such defenses are economical, or even if the idea of their employment is sound. You will find no commander of a land base neglect to avail himself of the tactical advantages to be gained by the occupation of physical features surrounding his post; he will also strengthen them by entrenchments, and by these means the object required will be secured with a smaller personnel than if the garrison were expected to meet the raiders on equal terms.

This is really analogous to the defense of a sea base.

Ordnance, sited in well-chosen positions, have an enormous tactical advantage over the same weapons afloat, and they are not exposed to the same vicissitudes as are those in floating batteries; a very liberal margin of strength will be required to allow for these vicissitudes, if the latter form of defense is to be relied on.

We shall see later on that fixed defenses in their proper sphere have so generally acted as a deterrent to attack, that their utility has been overlooked. It is, moreover, because the naval man has rarely known the want of them that he regards them so lightly.

#### COMPARISON WITH LAND FORTRESSES

Another argument advanced by Admiral Colomb is the inability of fortified towns to prevent an enemy overrunning a country. He quotes as an instance Metz and Paris.

But does any professional man entertain the idea that this is the aim with which fortifications are erected?

Land defenses have their uses although they cannot replace a field army. It is not sound to say that fortifications are a mistake because occasionally an active army gets shut up in one instead of using it as a pivot of maneuver.

Colomb remarks "Fortified towns may hold out\* all over the land empire, yet if the armies of the enemy hold the roads between the towns, the towns are bound to fall in due course, and perhaps without attack of any kind."

This is quite true, but equally it is beside the mark; the French experts responsible for the fortification of certain strategical positions are probably as well aware of the fact as Admiral Colomb, but are also well informed as to what is the real object of fortification. Besides delaying the advance of the enemy and thus affording time for the completion of mobilization, and absorbing part of the forces of the enemy in masking them, land fortifications can be

\* *Essays on Naval Defense* (page 23).

legitimately expected to protect the strategical deployment of the Army at the commencement of hostilities; to act as points of maneuver for the field armies; to protect important junctions in the lines of communication, and to secure depots and magazines against sudden surprise by swift moving bodies of the enemy, such as independent cavalry.

Making due allowance for environment, I think it may be shown that fortified bases perform very similar duties for the unbeaten fleets of a belligerent fully prepared to take the initiative.

Yet it is not wise to unduly exalt their value without a careful investigation of the reasons for arriving at an estimate.

It is universally admitted that the only way to secure naval supremacy is by possessing a Navy strong enough to crush any combination of possible enemies.

A strong Navy depends on two factors.

- (a) Numerical strength.
- (b) Individual efficiency of the unit.

This latter factor depends in its turn on two conditions—

- (1) Superiority of the personnel.
- (2) Maintenance of the material.

This includes not only provision of supplies of all kinds, but facilities for every kind of repair.

*Ceteris paribus* the unit which has better facilities for the maintenance of its material in any area of operations will be the more efficient.

These facilities are best afforded by naval bases, suitably equipped with docks, workshops, ammunition, coal, and other supply stores.

The nearer these are to the strategical center of operations the more value will they possess to a belligerent.

It follows that if the possession of a suitably placed naval base increases the efficiency of a unit, the loss of it will decrease that efficiency: therefore the destruction of a naval base must be a direct blow to the fighting strength of an adversary, and is a legitimate objective to a belligerent in a struggle for naval supremacy: as a consequence the other belligerent must do his best to defend it.

I think it must be conceded that any defenses provided to protect the naval base are in reality not a "complement to the Navy" as suggested by Sir John Adye, but an integral part of the naval force.

#### "LOCAL FORTIFICATIONS AND A MOVING NAVY"

There is one argument of Colomb's that this reasoning does not touch. It is this. To the naval Commander it is immaterial whether his operations are interrupted by the destruction of his base, or by his communications being cut at sea.

In his 6th Essay "Local Fortifications and a Moving Navy," p. 177, in criticizing "Captain Stone's postulate of the relations between the fortified base, and the squadron which is attacking the enemy's arsenals," he supposes that an Admiral is bombarding Brest with 10 battleships, and that he is enabled to do it because his base, Plymouth, is securely fortified.

He then supposes that an enemy's force of 5 battleships cuts his communication by lying off Penlee Point, just clear of the Plymouth batteries.

He argues that in this case the British Commander has no choice but to discontinue his operations and drive off the enemy threatening his communications, and on this he founds the following argument.

"The whole theory of fortifications at the base 'relieving' the naval force falls to the ground.

"Plymouth, separated from him, is as bad to him as Plymouth destroyed, and the threat of separation governs his conduct in precisely the same way as the threat of destruction does. As far as I can carry my reasoning powers, this hypothetical case is conclusive, and it governs the circumstances of every open port which is fortified.

"There remains no ground for saying that the fortification of a port, which it is necessary to keep open, will in the slightest degree relieve the naval force.

"But suppose Plymouth in this case to have no fortifications at all. What then? I imagine it will be said that 5 battleships would steam up and destroy the dockyard, and so do a permanent injury instead of a temporary one.

"If so the Brest fleet must still come home just as before, and therefore there is no effect on the fallacy that the fortification of the base, or open port, will relieve the naval force.

"But an inner question arises as to whether five battleships would steam up and damage, even if it were entirely unfortified? Naval history as far as it goes, is conclusive with a negative answer. It tells us that the neighborhood of a possibly interfering naval force is a complete bar to any attack on the shore whatever."

It appears as if the author, in order to let down the landsman as lightly as possible, has accepted an incomplete state of affairs on which to found his argument.

It is not possible to appreciate a situation without a knowledge of all the factors affecting that situation.

Before we can imagine a British fleet bombarding Brest, we must know what has become of the fleet based on that port. If inside there is a fleet "in being" of say eight ships, then it is fairly certain that the English fleet will be employed in watching and not in bombarding, and further that the enemy's aim will be to get that fleet safely to sea in order to effect a junction with the remainder of his forces, or for some other ulterior design.

If the foreign fleet is unbeaten and at sea, then the Admiral would not be watching Brest at all, unless another English fleet strong enough to destroy the enemy is told off to deal directly with him. We must therefore assume that an inferior fleet is in Brest; not very inferior, for no more than the minimum number requisite were ever told off for the duty of observing; the object was invariably to tempt the enemy to sea.

In that case to lose touch with Brest would be to play the enemy's game. Would a hostile force, temporarily interrupting communications with the English fleet off Brest, really necessitate the latter's return to drive the former off?

I think the answer must be in the negative, because any fleet must be self-supporting for a short time.

The true solution seems to be that the setting of the chess board is incomplete. No strategist in chief could have sent a fleet on such an errand unless he had forces at his disposal capable of neutralizing all those of the enemy; and, if the base is safe for a limited time, they will inevitably be called into play, and the line of communication again established.

It must be remembered that, besides the stores, ammunition and docks, the safety of which is a most important asset to the supreme director of the

Navy, whatever it may be to the Admiral at Brest, Plymouth must contain a proportion of the fleet off Brest, for it is an axiom that a blockade cannot be maintained without reliefs. These ships, in dock, or refitting, cannot protect themselves, and yet their loss might necessitate the permanent abandonment of the blockade. I cannot therefore imagine the authority ultimately responsible for British strategy as a whole taking the chances in leaving Plymouth defenseless.

It is, however, with the last paragraph of the quotation from Admiral Colomb's essay that I join issue. I propose to show by instances drawn from naval history that the assertion that "a possibly interfering naval force" is not a complete bar "to any attack on the shore whatever," unless naval bases are expressly excluded, though as regards our home ports history must of necessity be silent, as they have been fortified from the earliest periods of naval warfare.

## II.—INFLUENCE OF FORTIFIED BASES ON NAVAL STRATEGY

Having now indicated some of the difficulties surrounding the question of the utility of fortified naval bases, the time has arrived to formulate their claims to influence on naval strategy.

I shall endeavor to show—

1. That the distinction I have made between attacks on naval bases, and descents on territory is sound, although not generally recognized by naval historians, or even by our own regulations.

2. That in planning a naval campaign the strategist must perforce take into consideration amongst other factors, the geographical situation, strength, and other peculiarities of the naval bases belonging to either side; and that they will have a marked effect on the strategical dispositions adopted at the commencement of the campaign.

3. That during the progress of that campaign the influence of naval bases will continually make itself felt, sometimes directly, sometimes indirectly; but always as a force that it is impossible to ignore.

4. That the protection of naval bases, primarily by fixed armament, is a sound policy, because it is the most efficient, as well as the cheapest and most durable method that can be adopted.

## THE EVOLUTION OF NAVAL WARFARE

Let us now glance at the evolution of naval warfare as a separate branch of the military art, and see whether any arguments can be deduced from the examination to support my theory.

In the middle ages, naval architecture was in a primitive state, consequently long voyages were almost an impossibility, and sea borne commerce was of little importance, territories beyond the oceans were hardly dreamed of, and European interests were confined practically to our own Continent.

The attention of strategists was centered on the land, where alone decisive pressure could be brought on rival states.

In those days warfare was essentially a land operation; the vessels being merely the vehicle to convey the combatants to the scene of action; even if the belligerents encountered each other on the seas the conflict was in all essentials a land fight.

Moreover the principles of strategy were often subordinated to other material considerations.

States were mostly small, and revenues inelastic. War therefore when undertaken had to be made immediately profitable in order that the requisite forces might be maintained in the field. Then again the majority of fighting men were purely mercenaries, and had no real desire to cut short their time of harvest.

For these reasons history records a series of raids and counter raids undertaken with apparently little ulterior object beyond petty damages and plunder. Whether carried out by land or sea such expeditions contain few lessons for the student. A fairly high state of civilization, including a powerful central government, seems indispensable for the development of scientific warfare.

At this period there seems to have been only one class of fighting man. The origin of the sailor as a new variety of the species has been traced to the growth of the sailing ship as a new weapon of war, which could only be used to the best advantage by the specialist, who thoroughly understood its capabilities.

When the sailing ship had developed sufficiently to keep the seas for lengthy periods, new conditions arose.

Oceans were crossed, discoveries of new lands made, with the result that commerce received an enormous impulse, and the oceans over which wealth poured into the old countries afforded a rich harvest to those who attained the necessary skill to make use of the new weapon.

Wealth at sea called for protection, and forces were sent out to prevent plundering as well as to plunder.

Under new conditions, strategy dictated such different dispositions that it appeared to the student that warfare conducted by sea and land were two totally different arts. In reality the broad principles remained the same; if the landmen failed to arrive at the true solution it was because one of the factors, that involving a knowledge of the value of the ship, was an unknown quantity to them, and not because there was one strategy of the earth, and another of the water. Anyone who upholds this latter idea will be called on very shortly to admit of the existence of a third strategy—that of the air.

#### THE PROTECTION OF COMMUNICATIONS

It is equally true in warfare, either by land or sea, that the best method to protect one's base and lines of communication is to cover them by the operations of the main body.

The idea of blockading an enemy's ships in his own ports is merely the development of this principle by the naval specialist, who recognized that the enemy was most easily found and contained at his point of departure.

This, however, only became possible in comparatively recent times when naval architecture had gradually improved its weapon (the ship) sufficiently for it to maintain its position in spite of ordinary bad weather.

When this improvement enabled him to carry it out, it was the sailor's part to adapt to his immediate environment the general strategic law recognized from the earliest dates of civilized warfare.

It has been ever thus, the brains of the thinker are always in advance of the practical manufacturer. The advantages to be obtained from breech loading rifled guns were known many years before any practical application could be made of the knowledge. The inventor had to wait until metallurgy and machinery had advanced sufficiently to realize his dreams. So with the submarine.



The flying machine is an even better example of my meaning. Attempts at flying date back to mythological ages, but it was only with the advent of the petrol engine that the inventors' ideas began to assume a concrete form.

The men who were making history, were as a rule too busy to record the principles on which they worked.

If, when the specialist subsequently turned to the task of deducing principles as a guide to the future, he only found plain narratives unaccompanied by any reasons for the various moves; it is not to be wondered at that he considered he had formulated fundamental laws, special to his own service.

The seaman who arrives at the conclusion that territorial attacks cannot be successful until the "Command of the Sea" is secured, has not in fact elucidated a new strategic principle.

The sea in this case affords the lines of communication.

In land warfare lines of communication must be secured, and success or failure often turns on the skill with which the operations of the main force conduce to this object.

As that part of the lines of communication which cross the water can only be attacked or defended by ships, it follows that the Navy of the offensive force must contain that of the defense, but this is all that is meant by securing the "Command of the Sea," so we see after all the "Command of the Sea" theory is nothing but the strategic principle, as old as civilized warfare, though the tactics adopted to carry it out are founded on accumulated naval experience.

#### NAVAL AND MILITARY OBJECTIVES

If, in this struggle for maritime supremacy, the naval commander finds that he can best attain his object of crippling the enemy's naval power by burning his stores, destroying his dockyards, or sinking his ships in harbor, that is a naval operation, just as much as if he fought a fleet action on the high seas. If in pursuance of his objective he finds it less costly to land his sailors, does it alter the status of the action? I think not. Again, if he carries with him in transports a body of men trained to fight on land, is the objective any the less naval?

The objective and not the means adopted, settles the category in which the operation must be included.

For instance, the siege of Port Arthur, undertaken directly to destroy the Russian Pacific Fleet, in order to prevent its future junction with the Baltic Fleet, was a naval operation, and cannot be justified on any other grounds; whereas when Nelson sent his sailors and marines to Capua from Naples he was undertaking a land operation. His objective, which was to drive the French out of Neapolitan territory, was distinctly non-naval.

You cannot draw an arbitrary line between naval and military action at the 5 fathom line or at high water mark.

Let us apply the test of Naval History to these deductions.

It is wise to lay down clearly the information for which one is seeking. This may be stated as narratives of operations conducted against a Coast Fortress under the following conditions:—

1. The naval commander must be one of the first rank.
2. The objective in view, a definite advantage to the Navy.
3. The period, one in which the maritime supremacy is not assured.

If we can cite a sufficient number of incidents answering to this description to counter the argument that the circumstance was a special one, we may

then conclude that the hypothesis is proved on the principle of the *reductio ad absurdum*; for if action under these circumstances against Coast Fortresses must be classed under the same category as invasion of territory, then the very strategists, on whose authority the teaching of Naval Historians is based, frequently acted in defiance of those fundamental laws we are taught they established.

As, however, an examination of a campaign for such a purpose must of necessity also offer opportunity of studying the part played by Naval Bases, both prior to, and during hostilities, to confine oneself to the consideration of my first proposition apart from the remainder would entail needless repetition.

I shall therefore call attention to the deductions that I wish to draw from the narratives as we proceed.

It will be noticed that I have departed from chronological order in arranging my historical proofs.

My reason for so doing is that, it is only when the coast fortress is recognized as an integral part of the navy, its influence on naval strategy can be viewed from a correct standpoint.

I have selected the period at the commencement of the Revolutionary War as my first example, on account of the instances of active operations against coast fortresses afforded by this epoch.

#### Example 1: The Mediterranean, 1793

##### (a) Toulon

On August 27th, 1793, Lord Hood gained possession of Toulon owing principally to the efforts of the strong monarchical party amongst the inhabitants.

The French fleet, however, to a large extent remained Republican.

Rear-Admiral St. Julien had manned the forts on the left side of the harbor; but, as the English seized those on the right side, which commanded those on the left, the French sailors evacuated the works and escaped into the interior.

During the period Toulon was held by the allies, the French cruisers, which were not handed over at Toulon, used the Corsican ports as a base. Nelson was put in command of a squadron of frigates to look out for them. The fortifications of San Fiorenzo, where they lay, afforded a complete bar to any attempt on them.

Toulon was evacuated on December 17th, and almost immediately Lord Hood concentrated his energies on the capture of the Corsican ports.

##### (b) San Fiorenzo

Commodore Linzee had made an unsuccessful attack on San Fiorenzo in October, in which his three line-of-battleships, two 74's and one 64, were roughly handled.

Owing to various accidents, on the recovery of Toulon the French Government regained a great part of their fleet, including 17 line-of-battleships. Corsica was of great importance to them, as it furnished wood, tar, and many other naval stores which they could not import from the Baltic.

Hood's object was therefore two-fold; not only to secure a base for his own command, but to deprive the enemy of the stores he needed to refit a formidable fleet.





“In the last there are four guns of different calibres; 150 or 200 men from the garrison of San Fiorenzo guard these different works. They are chiefly designed to act against shipping, but are commanded by heights in their rear. If these are occupied by cannon the works must be abandoned. The road leading to the heights has generally been thought impracticable for cannon. It is, however, by no means so for light guns or howitzers. I annex a detailed plan concerted with General Paoli for the attack on the works of Martello, by landing a body of 500 men with light field pieces at the northern point of the Bay, and marching by a path, which has been reconnoitred, under cover of the hills to a place called Vechiagia, which commands within a few hundred yards the new redoubt and the tower of Tornoli.”

When the attack was determined on, Sir J. Moore (then Lieut.-Colonel Moore) was in command of the landing party. He says:—

“My orders were to march to Bocca Fattojagi, and, from the heights in that neighborhood, which overlook the enemy’s works, fire upon them with the 6-pounder and howitzers, and then attack them with the infantry.

“I reached a small plain at the foot of the hills, from which the Bocca, about twelve at noon . . . Major Pringle and Captain Stewart ascended the hill with me, and we reached a point within 1400 yards of the enemy’s works.”

Sir J. Moore then proceeds to relate how mortified he was to find how greatly the defenses had been strengthened since he had reconnoitred them three weeks before; but from his enumeration of the additions we can see that the chief anxiety of the enemy was directed against attack from the sea.

No works crowned the heights, which do not appear to have been held even by picquets.

The result was disastrous enough to the French then, but in these days of long-range small arms an unfortunate garrison in the same plight will not be allowed any respite on account of the difficulties of transporting ordnance.

It will be also advisable for us to ponder on the carefully-thought-out plan which enabled the attacking party to occupy the key of the position so quickly that the fate of the fortress was sealed from the first; a very different procedure from the haphazard dash which is popularly associated with an attack from a squadron.

Future wars may produce men just as efficient as Sir J. Moore.

In most fortresses there is some dominant spot, which, if seized by the enemy, will render the rest of the position untenable.

It seems a matter of common sense that no effort should be spared to prevent such a key being occupied by a *coup de main*.

This can only be done by detailing a special garrison, and strengthening the post by suitable works.

Fortresses, being permanent, we must be prepared to find that the enemy has an accurate knowledge of the terrain, and will find his way to the spot, with the utmost celerity even at night, when extemporized field works and obstacles are of little value, owing to the difficulty of keeping up an accurate fire.

The value of a permanent obstacle lies in the fact that heavy material such as scaling ladders or fascines become a necessity, and the difficulties of a surprise by a small party are at once enormously enhanced.

Such material has not only to be prepared beforehand, and even then may be unsuitable, but the conveyance to the spot by a landing party is a serious

undertaking, and inevitably makes for delay, as well as increasing the size of the party, and thereby rendering discovery easier.

To anyone on whom the task of directing a defense, even in maneuvers, has fallen, the arguments against the employment of a citadel, so strenuously urged by Admiral Colomb, will not appeal.

The task of collecting decisive strength in sufficient time to oppose such an attack under modern conditions is enormously enhanced, and the wear and tear, owing to suspense and uncertainty, is all against the defenders.

This is a most important point, because it is this systematic fortification which Admiral Colomb specially attacks in *Naval Warfare*, p. 223.

It is impossible to attempt any criticism without quoting at length; there is so much danger of misrepresentation in short extracts without the context. I therefore give the whole passage I am alluding to.

"It seems to have been understood that direct assault from the sea was so inherently difficult, that very slight works guarding against it would always turn the direction of the enemy away from that kind of attack, to one more certain and more easy from the land side. And this being so the idea of a 'citadel,' descended apparently in a direct line from the mediaeval 'keep,' seems to have nearly always governed the system of fortification adopted.

"This policy of preparing a complete fortress as a citadel, supposed to stand investment and siege, obviously presupposed the occupation by the enemy of the surrounding country, and therefore assumed that his hands would be left free for whatever ravage and destruction could be compassed.

"This condition again implied the presence on the territory of an enemy's force superior to the garrison, for if the force landed were inferior to the garrison, it would be met and beaten before it was able to ravage and destroy; unless, indeed, its operations were so swift that they could be conducted before the garrison was able to put in an appearance.

"The provision of a citadel, therefore, presumed the successful landing of a superior force, and did not presume power of preventing destruction and ravage beyond a very small area surrounding the fortress.

"But it assumed the possibility of so delaying the final success of the enemy that either relief might come, or that the supply and reinforcement of the enemy might fail, before the fortress fell, and in that case the garrison recovered the possession of the territory.

"The citadel, however, if it was found competent to hold out until relief came, or the enemy's supplies failed, might prevent material ravage if all that was most precious and most necessary to preserve from ravage were assembled inside the citadel, or within the area protected by its guns.

"The existence of such an arrangement would naturally tend to preclude attack unless there was ample time for the reduction of the fortress by the usual methods.

"But this is only another way of saying that the heart of the invaded country lies in the citadel.

"If it is otherwise, and occupation is intended, and the country may be held without the possession of the citadel, the latter may be neglected, as it will fall by the mere lapse of time.

"An apposite reflection may here be made. If the possession of the citadel involves the possession of the territory, and it falls, the new possessors of it become as strong as the old ones. In other words, any defense of this kind—as we shall see in many examples—cuts both ways.

"A place difficult to take is difficult to retake, if the defense is fixed on

land; but a place depending on Naval force for its defense, that is to say a place difficult to take in the presence of Naval force, and only to be possessed by the holder of superior Naval force, may be much easier to retake than to take, as the Naval force which allowed the capture may prove inferior to that which comes to re-capture.

“The superior Naval power may suffer more prolonged losses of territory which he has fortified and garrisoned, than of territory which he has only garrisoned, and which is without a citadel.

“The Naval defense, that is the command of the sea over which alone a hostile approach can be made, is therefore on all grounds the most perfect. Apart from it, the territory can only be protected by a garrison, or a garrison with a citadel.

“Supposing a temporary loss of command of the sea, conquest of the garrison may be made by landing a superior force. On resumption of the command of the sea, and consequent stoppage of reinforcement and supplies to the new garrison, the territory is easily re-taken.

“But if the new garrison has possessed itself of a supplied citadel the task of re-capture becomes as much more difficult as the works of the citadel have added to the resisting strength of the new garrison.

“Supposing the superior Naval power admit the possibility of forces being landed on portions of its territory, it may be a question of policy whether the citadel as a substitute for a stronger garrison—which is its real character and office—is really a wise and economical institution.

“But we shall hardly avoid the conviction, I think, especially after a study of West Indian history, that command of the sea is the only real defense for territory which can be captured by expeditions over it.

“Whether our forefathers, or forefathers’ enemies, wisely spent their money over garrisons and works which generally failed when the time came, rather than over simply driving the enemy off those seas, and keeping them out of them by a superiority of Naval force, which never failed, is perhaps a question not to be determined as long as we are unaware of the relative proportions of the sums so spent.

“If the garrisons and works were wholly insignificant in cost compared with the sums spent on the endeavor to obtain and keep the command of the sea, we might possibly say that the minority of instances in which garrisons and works prevented the West Indian Islands from changing hands justified the policy.

“But if the former expenditure bore any considerable proportion to the latter, it might be possible to found an argument on the other side.”

The first point which strikes one in the above passage is the total absence of recognition of the use of the fortress as a naval base.

The author admits the possibility of a temporary loss of command of the sea, but still objects to the fortifications because it may make the fortress harder to re-take when the command is recovered.

The reflections at once arise in one’s mind: Need the fortress fall at all if properly fortified, garrisoned, and provisioned?

Would not the difficulty of re-establishing command of the sea be greatly enhanced by the loss of the base, with its stores, docks, sheltered anchorage, etc.?

What would be the difference in loss of national wealth, and what would be the material result to the unfortunate people whose livelihood depended on the possession of the naval base during these transfers alluded to so lightly?

The successful defense lies in the activity of the garrison; but it is by artificially strengthening tactically-important positions that we free a large proportion of the garrison for offensive action.

The question whether all, or even one, of the Corsican ports would have fallen had the San Fiorenzo heights been effectively held, is too big a question to discuss exhaustively; involving as it does a very close study of the war in the Mediterranean till the evacuation of Corisca in 1796; but we may note that there is ample evidence on which to base a fairly strong argument.

We know that it was impossible to enforce a strict blockade on all the three ports at the same time, so that it was improbable that they could have been forced to surrender by starvation alone.

Before Calvi fell in August, Hood was deeply anxious about the activity of the French fleet, and Moore (*Diary*, Vol. I, page 119), wrote, "had the siege been protracted but ten days longer sickness must have obliged us to give up the attempt."

Whether the operations could ever have been resumed if once abandoned is very doubtful. The French fleet gradually improved as regards relative strength during 1795, and the French partisans amongst the Islanders made headway; the British fleet would, in the meantime, have suffered for want of the very base it was striving to acquire.

#### (c) *Bastia and Calvi*

Lord Hood next turned his attention to Bastia.

We are not concerned with the account of the unfortunate disagreement between the two services: my object is to draw attention to the opinion of one of our great naval strategists as to the necessity of gaining possession of a coast fortress by active operations. It is summed up in the following letter to General Dundas, which was in answer to one written by the latter objecting to undertake the siege until he had received the reinforcements he thought necessary:—

"However visionary and rash an attempt to reduce Bastia may be in your opinion, to me it appears very much the reverse and to be perfectly a right measure, and I beg here to repeat my answer to you, upon your saying two days ago, that I should be of a different opinion to what I have expressed, were the responsibility on my shoulders, that nothing would be more gratifying to my feelings than to have the whole responsibility upon me, and I am now ready and willing to undertake the reduction of Bastia at my own risk with the force and means at present here, being strongly impressed with the necessity of it."

Bastia eventually surrendered after a land siege of 37 days, and Calvi, which was subsequently attacked, after 51 days, on August 10th, when two more French frigates were surrendered.

#### (d) *Gourjean Bay*

During this period the French fleet was more or less active. Seven sail of the line, one 120, two 80's, and four 74's, and four or five frigates put to sea on 5th June, and Lord Hood went in search of them with 13. On this the French took up a position in the defended anchorage in Gourjean Bay, where they were too strong to be attacked.

I quote as my authority Nelson himself, *Nelson's Despatches*, page 495, Vol. I.:

*"Agamemnon," October 10th, 1794.*

*Off Gourjean Bay.*

To—

*Captain William Locher,*

*Lieut.-Governor Greenwich Hospital.*

"The French ships in the Bay are so fortified, that we cannot get at them without a certainty of the destruction of our own fleet.

"At Toulon six sail of the line are ready for sea in the outer Road, and two nearly so in the Arsenal.

"When *Victory* is gone we shall be 13 sail of the line, when the enemy will keep our new c. o. in hot water, (Hotham) who missed, unfortunately, the opportunity of fighting them last June."

Vice-Admiral Hotham with nine ships of the line, one of 100, two of 98, and six of 74, was left in observation, and Lord Hood returned with the *Victory* 100, one 98, and two 74's to press the siege. It is worthy to note that large numbers of sailors were employed on shore, although Lord Hood's correspondence during the period reveals his anxiety about the activity of the French fleet.

This seems a positive proof of the great importance that he attached to the possession of the place. His reasons appear to have been (1) It was too near his own selected base to allow it to remain in hostile hands, and (2) The importance of denying a base to the enemy may be as urgent as the acquisition of one for oneself.

In this connection Nelson's letter to the Viceroy of Corsica regarding the necessity of denying Ajaccio to the French is instructive.

*To the Right Honorable Sir Gilbert Elliot,  
Viceroy of Corsica.*

*"Agamemnon," San Fiorenzo.*

*November 10th, 1794.*

"My dear Sir,

"As I have been sent by the Admiral to examine into the state of the enemy's fleet at Toulon, I think it will be acceptable for your Excellency to have a copy of my report, more especially as it is given out that Corsica is the object of their attack, and very many in our service believe it. I own myself of a different opinion. Neither Calvi, San Fiorenzo, or Bastia can be attacked by them, unless—what I hope no Englishman will credit—that they are able to beat our fleet. We know from experience that an army thrown ashore without the possibility of being supported by a fleet to land all the requisites for a siege (which are many), however numerous they may be, cannot subsist long in an enemy's country. The Corsicans, if we keep them out of fortified places, would harass them to death.

"I shall take this opportunity of saying a word of Ajaccio. If the enemy have an intention of getting a hold in Corsica, that is the place they will attempt: and should they succeed we shall find it a difficult matter to drive them out again. I never was there, but it strikes me that by numbers landed, and the appearance of their fleet for a few hours they may succeed: for I believe the Corsicans understand nothing of the art of defending fortified towns.

"You will, I am sure, receive what I am going to say, as it is meant, well, and believe that all my wishes and desires are to see our country successful, and the schemes of our enemies frustrated.

"I am well aware it may be said, and with truth, that we have not troops in the island to defend any one place properly: I admit it; but in answer I say—and am satisfied in my mind that it will turn out so—if the enemy make an attempt, that a few troops and artillery stationed at Ajaccio, to keep the gates shut for a few days, would render abortive any schemes they may have for establishing themselves there. I think 300 men, and some artillery to keep the guns in order, to which, if a guardship were added, the seamen, in time of need, could go on shore and man the works (for if the enemy get Ajaccio, they may lay there with their whole fleet or leave a single frigate, neither of which we could attack; for in the Gulph there is no sounding, and a sea setting constantly in, which would make us keep at a distance).

"With this defense, I am confident the place, and I believe I may say the island, would be perfectly safe, till our fleet could get to the enemy, when the event, I have no doubt, would be what every Briton might expect: besides, we have the incitement (if any is wanted) of our Home Fleet (Victory of 1st June) and we shall not like to be outdone by anyone.

"I have taken the liberty of mentioning my idea of the importance of Ajaccio, only in the belief which I have, that your Excellency will receive it as a private communication (my situation does not entitle me to give any public opinion on such a point); as such I send it and shall be happy if it gives rise to a serious consideration of its importance, when I doubt not much more proper modes of defense and security will be thought of than I have suggested.

"But however that may be, I am bold to say, none can exceed me in the earnest desire of serving well my King and country; and of convincing your Excellency how much I am, on every occasion, your most sincere humble servant,  
HORATIO NELSON.

This letter indicates so clearly the strategical advantage Nelson considered to be inherent in the possession of the port, and his belief in the value of fortifications.

Altogether this period of history appears to afford so many contradictions to the school of extremists that it is specially valuable.

We see first the safety of an inferior fleet secured, first by Toulon, and then by Gourjean Bay.

Secondly, we see this fleet enabled to compel the superior to take up a position at a strategical disadvantage.

Thirdly, the efforts of the superior fleet to improve its position by seizing a suitable base, and the consequent employment, not only of land troops, but of considerable drafts from the ships themselves, in actions which Admiral Colomb classes under "territorial attacks," and these operations continued in order to deprive the inferior, but still active, enemy of a well-placed advanced base, which might prove a useful asset in the contest for which he was then preparing. We also get an idea of the fallacy that such command of the sea can be acquired as to cause advanced bases to fall without attack; at all events as long as one force, based on impregnable harbors, declines to commit itself to a fleet action.

Finally we get a good, but not exaggerated, example of the relative value of well-sited land batteries in action against ships.

—*Journal of the Royal United Service Institution.*  
(To be continued.)





## MANUFACTURE AND TREATMENT OF STEEL FOR GUNS—II\*†

AN INDUSTRY OF ABOUT THIRTY YEARS' STANDING

By GENERAL L. CUBILLO

(Concluded)

## III. HEAT TREATMENT

Before proceeding further, it will be convenient to consider, at this point, the heat treatment most appropriate for gun steel.

The steel, having been cast in a mold of truncated cone shape, required, of course, to be forged, in order to give to the gun or part of the gun the required form, which is always that of either a hollow or a solid cylinder, of varying length, with different diameters outside, and sometimes also inside. The annealing after the forging, the hardening—or hardenings, if it is necessary to harden more than once—and the subsequent tempering or temperings, constitute the series of heat treatment processes given to the steel for gun construction. Forging is not only necessary for giving the required form, but principally to change the crystalline structure of the large and medium-sized castings into one of finer grain, almost amorphous, which is essential for the best development of the physical and mechanical properties of a given steel for ordnance purposes. But as it is possible to obtain from a given steel, simply by heat treatment, without the aid of the press or of the hammer, physical and mechanical properties equal to those conferred by forging, it is only natural to ask if the forge is absolutely necessary, and whether, instead of casting ingots of the usual shape, it would not be possible to cast pieces of approximately the final form, and subject them afterward to the heat treatment capable of modifying the texture developed by the cooling after the casting. This is a question which has been very much discussed for many years, and opinion seems on theoretical grounds to be in favor of the suppression of the forge, but on practical grounds the forge is retained, and there is no indication whatever that it is likely to be dispensed with.

The manner of fixing the amorphous structure obtained by heat treatment is to cool the piece very quickly. For thirty or more years these facts appear well established, yet the specifications of all the armies and navies of the world continue to require the use of the forge in the manufacture of gun steel, notwithstanding that eminent metallurgists have demonstrated the possibility of making very good pieces for gun construction without the aid of the forge. The tests were certainly made with small pieces many years ago, but an enterprising firm in Sweden now makes guns up to 24 centimeters caliber without forging. In 1882 Mr Pourcel, in a paper read before the Iron and Steel Institute, described the series of operations which constituted the whole process at the Terre-Noire Steel Works in the manufacture of steel hoops for 4-inch guns. These hoops must, of course, satisfy the same specifications as those required for the forged metal. After casting the steel with the necessary additions of ferro-silicon for freeing the ingots from cavities and securing a perfectly sound metal, a heat treatment was given to the hoops, which consisted in heating them to a yellow heat and hardening them in an oil bath of fixed weight. After being cooled in the liquid they were afterward reheated to a temperature which varied from light cherry red to a dark cherry red,

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\* *Iron and Steel Institute.*

† Continued from JOURNAL U. S. ARTILLERY, January-February, 1913.



in accordance with the chemical composition of the metal. The hoop was then cooled in a bath of the same liquid, where it remained until it was perfectly cool. By the first hardening the crystalline grain of the metal was transformed into a finer and homogeneous grain. The second hardening confers on the pieces molecular equilibrium corresponding to their chemical composition.

The result of these two operations was a true hardening, inasmuch as the piece was heated to a higher temperature than that of the transformation point, and by this the size of the original grain was changed, and the new structure fixed by subsequent cooling in a large quantity of oil.

The second heat treatment, also called hardening by Mr. Pourcel, was, rather than a hardening or annealing, a true tempering, which caused the disappearance of the strains originated by the hardening, and increased the ductility, which had been lowered by the first operation. Sometimes it was necessary to repeat the two operations, if the tenacity of the metal was less than that required by the specifications, or only the second if the ductility obtained was less than required. Mr. Pourcel had some doubts at that time if this process, applied to guns of a caliber larger than that of 4 inches, would give the same excellent results. His conviction inclined him to take the affirmative side of the question. Undoubtedly he had thought the subject out in a logical manner, and it is not easy to understand why such ideas as these, so well grounded, have not been adopted by metallurgists. The Swedish Steel Works, the Aktiebolaget Bofors Gullspang, for many years has been successfully applying steel as cast to the construction of guns. Working systematically, and passing gradually from the simple to the complex, it began by producing field guns, followed by the fortress guns, and finally essayed the manufacture of coast and navy guns, commencing with a quick-firing gun of 15 centimeters in caliber. The United States of America even used a gun of this type, the trials of which were commenced in 1902, and gave exceedingly good results.

Recently, the author has ascertained that the Bofors Steel Works has constructed guns of 21 centimeters and 24 centimeters, whose elements have been simply cast and afterward subjected to heat treatment. Of course, the elements for the field and fortress guns are also subjected to proper heat treatment. These are facts the importance of which it is impossible to deny. They afford evident proof of great advance in the way of applying heat treatment alone without forging the elements of guns. The author thinks, however, that it is no easy matter to cast 10-inch and 12-inch gun tubes 50 calibers in length, molding them in a refractory mold.

There is another reason against the acceptance, by governments, of this process of manufacture. It may happen that, despite all the precaution and care taken in the finish and casting of the elements in order to obtain pieces absolutely free from cavities, a cavity may occur in the thickness of a tube without being detected during the mechanical work, and may cause the bursting of the gun when firing.

*Hardening and Tempering.*—If forging is necessary, or presumably necessary, in order to obtain first-rate elements for the manufacture of the guns, the hardening process is also necessary for the tempering. To obtain these properties in the highest degree must be the supreme object of the metallurgist. The author, during many years' experience in the manufacture of steel, both by the crucible and openhearth processes, for 24-centimeter guns of 45 calibers in length, has found that however well conducted the forging,

the transformation of the crystalline structure into one of amorphous, or fine grain, is only obtained in the highest degree—if the forging is not completed—by hardening and tempering, and sometimes more than one and more even than two such operations. As it is not the chief aim of the hardening—in semi-hard steel of the type used for gun construction—really to harden the metal, and as it is easy to obtain the required mechanical qualities by forging only—followed by an annealing—it would seem that the hardening might be dispensed with. However, as many years ago hardening in oil was introduced with excellent results, the process was retained and formed part of the specifications. The study of iron-carbon alloys has shown the great advantages that can be derived from an adequate heat treatment of the steel.

The most important point in forging is to fix the limits of the temperature within which it is possible to conduct it. The highest, of course, must be the temperature at which the cohesion of the grains of metal begins to weaken and the grains to separate; this last action is due also in part to the gas evolved from within the mass. The generally admitted hypothesis is that this gas is carbon dioxide formed by the oxygen passing through the metal and combining with the carbon, though it is possible that carbon monoxide and other gases, such as nitrogen and hydrogen, are also given off. When a steel is in this state it is said to be burnt, a condition which is chiefly distinguished from the overheated state by the separation of the grains. To this can, perhaps, be added the great thickness of the ferrite network, which is found when the steel cools through the temperature interval  $Ar^3$   $Ar^1$ . It can be said that the upper limit of temperature for forging the steel for gun construction is between 1100 to 1000 deg. Cent. The lower limit must be that of the transformation of the metal, as below this temperature the structure is not changed. This is the natural and logical limit; but some authors, especially Tschernoff, think that forging at lower temperatures is convenient. But certainly Tschernoff would find it difficult, and even impossible, with the means at his disposal when he wrote his celebrated paper, to forge the large mass required for great guns at temperatures below the transformation point.

Coming now to the practical aspect of forging large ingots for gun construction, it must be emphasized that it is necessary to heat them very carefully and slowly. If the temperature of the furnace, when the ingots are introduced, is rather high, it is better to pre-heat them. Certainly, the temperature of the furnace is suddenly lowered by the introduction of cold ingots, which naturally take a great part of the heat lost by the furnace; but this heat, taken up suddenly, causes a sudden dilation of the outside of the ingot with the natural consequence of cracks, and it may occasion the breaking of the ingot across. This happens especially if the metal is somewhat hard. The two reheating furnaces for the great forging press at Trubia are of the Whitworth type. Their doors are worked by hydraulic power. The largest ingots until recently, forged at Trubia, were 42 tons weight, suitable for the forging of the tubes and other elements of the 24 centimeters and 45 calibers. As an instance of solid forging, that of the *A* tube for the 24-centimeter gun may be taken. The ingot on being taken out of the mold was 16 feet 6 inches in total length, of which 13 feet corresponded to the pyramidal part, cast in the metal mold, and the other 3 feet 6 inches to the conical part cast in the refractory material attachment. The diameter at the two bases of the truncopyramidal part was respectively 4 feet 10 inches and 4 feet. The main diameter of the truncated cone part was 2 feet 8 inches. (See Fig. 3.) The ingot free from all cracks, and reduced to a diameter of about 2 feet 8 inches

by the previous forging, was put in the furnace, where it was heated carefully and very slowly during thirty hours, which is a sufficient time for the whole mass to become well and uniformly heated throughout. The temperature, as already stated, was 1100 deg. Cent. approximately, and the forging operation is suspended at 700 deg. Cent., when the ingot is put into the furnace again. The operation was finished in three heats, and the time taken to complete it after the first heating was fifteen hours. The tube weighed 18.5 tons after forging, and its dimensions are given in Fig. 4. For the hollow forged tubes and hoops, 40-ton ingots are also employed. From each ingot two *B* tubes are forged. The operation of removing the cracks and also of

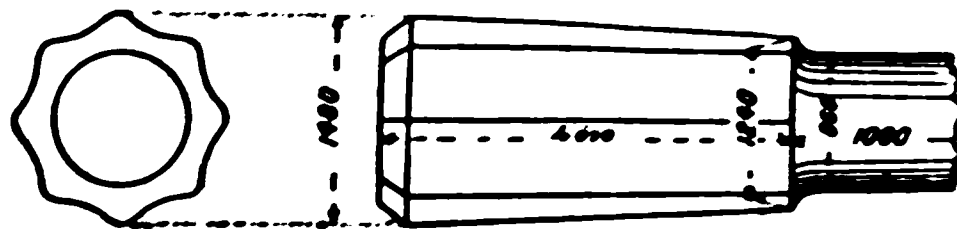


FIG. 3.

1250

Ingot for a 24-centimeter gun

the previous forging are the same as those practiced with the ingots for the *A* tubes. Afterward the blocks are sent to the large boring machine supplied by Sir William Armstrong, Whitworth & Co., where they are bored from both ends at the same time to a diameter of 1 foot right through. When this operation is finished, the ingot is cut into two halves. The reheating is performed in the same furnaces and conducted with the precautions already described in the case of the *A* tubes. The duration of the first heating is thirty hours, and the first operation practiced is that of enlarging the bore in a Whitworth drawing press. When the operation is finished throughout the length of the tube, the latter has a larger diameter and less thickness than at the beginning

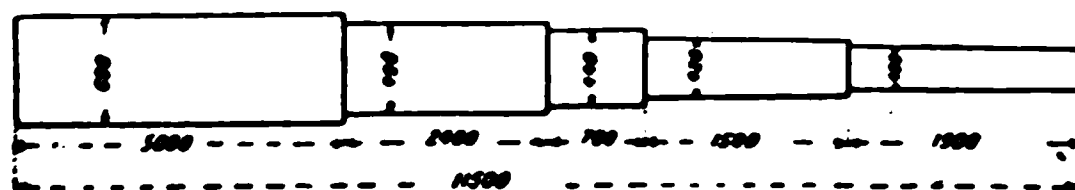


FIG. 4.

1251

Dimensions of an 18.5-ton tube after forging

of the operation. The tube then goes again to the furnace, and after careful heating the forging is continued, and it is again stretched on mandrils of different diameters. The full operation involves four reheatings, and the total duration is from thirteen to fourteen hours, the final dimensions of the tube being: Total length, 17 feet 2 inches, and outside diameters 2 feet 4 inches, in a length of about 20 inches, and of 2 feet 3 inches in the rest of the piece. The inside diameter is 14 inches. The great hoops are forged by means similar to those employed with the *B* tubes. Sometimes when the ingots from which they are obtained are not very long, the hole for the mandril is punched in the press after being carefully reheated, instead of being bored in the machine. This operation is made in one heat, the hole being driven by a conical steel tool which enlarges and lengthens the hole. When half of the ingot has

been treated, it is turned and the operation repeated on the second half. It is preferable to bore the ingot, because in this manner the steel of the central part, with a chemical composition distinct from the rest of the ingot due to segregation, is eliminated. Forging after boring must be practiced—in preference to forging the solid ingot—when possible, because the action of the press is more energetic in the first than in the second case, the press acting on less thickness of metal. With hoop No. 1 for a 24-centimeter gun, forged hollow, the following notable tensile results were obtained after the full heat treatment. At one end of the hoop, the mean result of three test bars was 25 tons per square inch tenacity and 17 per cent elongation measured in 4 inches, and at the other end 54 tons tenacity and 17 per cent elongation, conditions better than those ordinarily specified for nickel gun steel.

*Annealing After Forging.*—This is an indispensable operation in the manufacture of steel for guns. If it were possible to finish the forging of a piece in one heat only and in such a manner that the whole piece was finished at an even and correct temperature, then, in this case only, the annealing operation could be dispensed with. Some think the operation superfluous as the piece must be heated to a higher temperature for the hardening process or to a temperature at least equal to that required in the annealing. But forging cannot be conducted in the ideal manner just described, nor is it possible, in the last period, to heat the *A* tubes for large guns uniformly throughout their length. The lack of uniformity in the finishing temperature requires that the pieces should be annealed before passing to the machine shops, to be prepared for the hardening process. After annealing the metal will be in the best possible state for the turning and boring operations, and the pieces are less likely to suffer deformation during handling. In being reheated preparatory to hardening they retain their shape better, and in taking them out of the furnace for cooling they are less likely to bend and they undergo less deformation in the process of hardening. The slight deformation in the finishing mechanical operations is also avoided, and exposure to direct sunlight has less effect. Owing to these special circumstances, the Government of the United States specify, in the construction of howitzers, that the shops of the Niles Company, in Hamilton, Ohio, must be always at the same temperature. At Trubia, for the annealing after forging, the same furnaces are used as for the hardening. The operation is conducted very carefully, the temperature in all parts of the furnace, and of the piece, being measured with a Le Chatelier pyrometer. When furnace and piece are at the proper uniform temperature, the gas is shut off, and the piece cools slowly in the furnace. Of course, the annealing temperature must be above the transformation point. The elements for field guns are annealed in a special furnace. Taking into consideration their small mass, they are not individually annealed, but eight or ten are put into the furnace at a time. They are heated to 900 degrees very carefully, and after reaching this temperature they are slowly cooled. The author thinks that the advantages obtained by annealing, after forging, are more marked in the elements for the field guns.

#### IV. HARDENING AND TEMPERING

The author has already endeavored to demonstrate the necessity of subjecting to a certain heat treatment the steel for gun construction. This heat treatment comprises one or more hardenings and temperings as required in order to satisfy the specifications; and the heat treatment must comprise precisely the hardening and tempering. It is also well to insist on calling the

second operation tempering and not annealing, because in preparing the pieces for this operation they are heated to a temperature below the transformation point. If they were heated to a temperature above that point and then cooled slowly the structure of metal created by the hardening process would absolutely disappear. Perfect hardening indicates in the metal a state of unstable equilibrium at ordinary temperature, because this state is that of equilibrium at a temperature above that of the transformation point. Mr. George Ede claimed that the hardening in oil for the elements of guns originated in England at Woolwich Arsenal. The process originated in consideration of the benefits derived from the hardening in oil of hard steel for tools, and in treating the milder steels employed in the manufacture of guns in the same way it was found that the mechanical properties were improved. Tschernoff, in his celebrated paper on the "Working of Steel," says that for securing uniformity and fine grain it is necessary, after finishing the forging, to reheat the piece to a temperature above the point *b*, which is that of the transformation in his scale, and then to fix the amorphous texture by rapidly cooling it; this amorphous texture will be more surely obtained, the rapidity of cooling being the same, the less the point *b* in the reheating be exceeded.

Tschernoff and Woolwich Arsenal coincide in the treatment after forging to be given to the elements for gun steel, and this has led perhaps to the process being adopted by some manufacturing firms in other countries. At the Krupp works the elements for guns are said not to be hardened and tempered. The author has explained in another part of this paper the reasons why the metal must be subjected to heat treatment, and it is not necessary to repeat them here. In England and in the United States oil is exclusively employed as a refrigerant liquid; in France and Spain (Trubia Arsenal) water is used. Between hardening in oil and hardening in water, the temperature, always above that of transformation, being equal, the difference is very considerable, owing solely to the rapidity of cooling. In accordance with the remarkable work of Le Chatelier, which forms a very interesting paper in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, No. 9, Vol. CVI., there is a well-marked difference in the rapidity of cooling a piece in water or in oil. This was well known from the time hardening was first practiced, but Le Chatelier measured mathematically the rate of cooling. He operated with very small pieces, and took into consideration the extreme interval of temperature, which must be rapidly passed for realizing the hardening. Knowing that the recalescence phenomenon is never produced on cooling to a temperature superior to 700 deg. Cent., and that the tempering is not influenced by temperature down to 700 deg. Cent., he only took into consideration in his experiments the time spent in passing from 700 to 600 deg. Cent., which time, all the remaining conditions being equal, gives a very accurate notion, almost mathematically exact, of the rapidity of cooling, and therefore of the energy of the hardening. The central part of the sample, hardened in pure water, employed five seconds in passing from the temperature of 700 deg. Cent. to that of 600 deg. Cent. In the oil hardening for passing the same interval forty-three seconds were required, that is, the time was seven times longer than with the pure water. It must be said that in this experiment of Le Chatelier with oil, the rapidity of cooling was much less in the interval of 190 to 100 deg. Cent., in which interval thirty seconds were spent. It is natural that this happens with all the refrigerant liquids, but in oil it is much more marked, and the explanation is, according to Le Chatelier,

that during the operation the oil is decomposed and the gaseous bubbles cause a circulation of the liquid, which must cease at the end of the cooling. From these experiments, confirming by a scientific method all that was known, it is possible to state what will be the difference of hardening which two elements heated to the same temperature and cooled in two liquids, both also at the same temperature, should take. If the elements hardened in both liquids were intended for large guns, and if they should possess great thickness, there would be sufficient reasons for thinking that none of the pieces would possess, at the ordinary temperature, the structure which it possessed at the beginning of cooling. But surely the piece hardened in water should be the nearest to this structure. Benedicks, in a paper recently read before this institute, has made experiments on hardening in a manner very similar to that of Le Chatelier. He says that the most important factor in the rapidity of cooling is neither the conductivity nor the specific heat, but the latent heat of vaporization of the liquid. The specific heat has a secondary influence, and it is possible to dispense with the heat conductivity. The necessary conditions for obtaining from a given bath an efficacious hardening are as follow:

1. A high latent heat at vaporization.

2. A low temperature, in order that the vapor bubbles, generated in the surface of the metal, might be easily condensed in the ambient liquid. Whatever may be the predominant factor in the rapidity of cooling, the hardening in water will always be more energetic than the hardening in oil. Therefore, there is no doubt that the hardening in water will require a subsequent tempering, more energetic at a higher temperature than would have been necessary if the hardening had taken place in oil, in order to enable the metal to stand the tensile and shock tests specified. Really the hardening temperature must be higher than that of the transformation point, so that in submerging the piece in the refrigerant liquid the cooling might begin when the steel is yet at a higher temperature than that of the transformation. At the Trubia Arsenal, in the hardening of the elements for gun construction, water, as already mentioned, is employed as refrigerant liquid. The hardening plant is shown in Fig. 5. The reheating furnaces are vertical, and are heated by gas from three Dowson producers. The large furnace is capable of taking pieces 40 feet in length, and has four inlets for the gas, regularly spaced. It is built upon the ground floor, and, as is natural in these conditions, the tubes are manipulated through a lateral port, hydraulically. The second furnace is of greater diameter than the first, and its length is 26 feet. It is intended for the reheating of the *B* tubes and hoops, also for the tubes of the medium guns up to 6 inches caliber. The water tank is situated between the two furnaces, and has the dimensions stated in the drawing. The water at the time of the cooling has a temperature of 20 deg. Cent. A 35-ton overhead traveling crane is driven by a rope worked by a steam engine, and serves the whole of the hardening shop. When this plant was installed twelve years ago the intention was to use oil as a refrigerant liquid, as was the practice at Trubia with all the guns manufactured before that date, which did not exceed 6 inches caliber. In accordance with this idea, four tanks capable of containing more than 100 cubic meters of oil were conveniently installed at the top of the building, under the roof, and another four tanks of the same cubic capacity were installed at the outside of the shop, and on a level lower than the ground floor. The hardening tank is in communication with the higher and lower tanks by means of a system of pipes which are worked by the necessary pass valves. A steam pump can elevate the liquid, when it is cooled, from the



lower refrigerant tanks to the higher, and during the hardening it is possible to maintain a constant current of oil in such a manner that that of the hardening tank should not take a temperature so high that the piece instead of being hardened is annealed. As is seen from the drawing, the capacity of the shop is limited to the hardening of elements for 10-inch guns and 45 calibers in length.

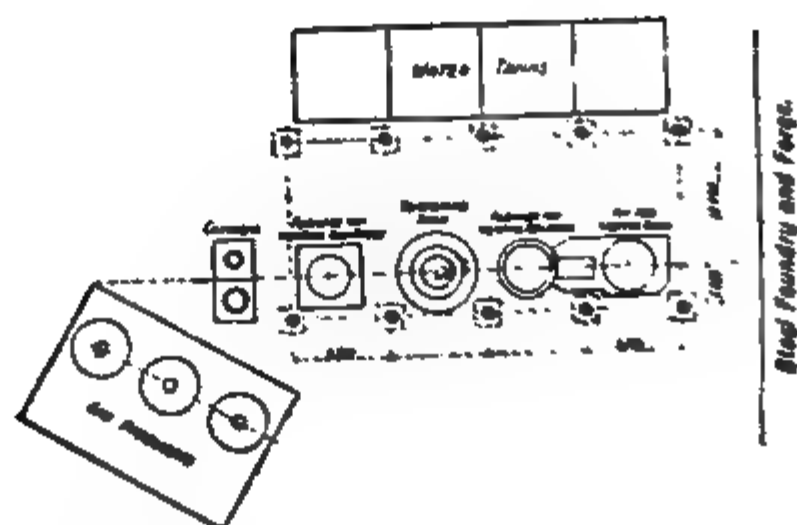


FIG. 5.

#### Hardening plant at the Trubia Arsenal

The measuring of the temperatures is done by the aid of the Le Chatelier thermo-electric pyrometer, registering the temperature of the tube or hardened piece at different points in order to distribute the heat in such a manner that the temperature may be uniform. Undoubtedly the best method is that followed at Woolwich Arsenal, with the long tubes for the 12-inch guns of 45 and 50 calibers, where four or five Le Chatelier pyrometers are used, with registering apparatus, and regularly distributed along the tube, that is both convenient and necessary when operating with tubes for of 34 feet in length, or perhaps more, with the excess length left at each

ends for the test pieces. It is really very difficult to heat uniformly the long pieces of variable thicknesses, and therefore to harden them. The difference of operating as physical experimenters do in their laboratories with samples of some grammes weight, and of dealing with 15, 20, 25 and 30-ton pieces, as is the daily practice of the manufacturers of gun steel, is enormous.

If tensions or compressions have been produced the layers of metal must be distended or compressed. Knowing the tensile characteristics of the metal, it is very easy to measure the intensity of the tensions or compressions, as they are of a purely elastic character, and it is possible to plot a diagram representing the variation of tensile strength in terms of thickness of the piece. In the ordinary practice of conducting the hardening operation in the tubes intended for gun construction the result generally is that the outside surface is compressed, that is to say, the contrary of what must be most convenient for the strength of the gun. With hardening in water, and dealing with carbon steel of 0.5 per cent, the tempering operation is absolutely necessary. Even when the piece has been heated and hardened with absolute uniformity, and the elastic tension caused by the hardening should be the most suitable for the strength of the gun, the tempering of the piece would be absolutely necessary, because the hardness due to the hardening would make it very difficult, if not impossible, to machine the piece in ordinary conditions of work, and the tensile, bending and dynamical properties would not be in accordance with the specifications. In hardening in oil, in nearly all cases, tempering at a very low temperature, in order to cause the disappearance of the light stresses originated, is sufficient, but in water hardening, and with metals of 0.5 per cent of carbon, the tempering temperature will be near that of the transformation point.

Ordinarily, that necessary for obtaining the best tensile properties is about 600 deg. Cent. It is clear that if these properties, after the heat treatment, are deficient from those specified, or lower than those required, it would be necessary to submit the piece to fresh heat treatment, raising the temperature of hardening and keeping constant that of tempering, or the same result can be obtained by giving the piece a new hardening at the same temperature and lowering that of tempering. If, on the contrary, the tenacity were higher and the ductility less than required, the results can be rectified by giving the piece a new tempering at a higher temperature.

#### COOLING CURVES AND MICROSTRUCTURES

Even though the cooling curves of different types of steel are well known, the author believes it useful to give in this paper those of both types of artillery steel, carbon and nickel steels—Figs. 6 and 7—the latter being employed in the manufacture of field and medium guns. Owing to certain difficulties at the Trubia laboratory, it has not been possible to obtain the curves of both steels from the liquid state. The range of cooling is therefore from 1000 to 500 deg. Cent. for ordinary steel, and from 950 to 500 deg. Cent. for nickel steel. Within this range are found the transformation points, so important for the proper treatment of the metal in all the heat treatment operations. Observing first the cooling curve of the ordinary steel, it is seen that the cooling is generally in accordance with the well-known Newton's law, and that the curve has only a well-marked point  $A_{r_1}$  at 684 deg. Cent. At this temperature the curve is converted into a horizontal line for a length of 20 millimeters, indicating 200 seconds, or 3 minutes 20 seconds. The temperature is therefore constant during this period, indicating complete equilibrium of



TEMPERATURE IN DEGREES C

TIME IN MINUTES.

FIG. 6.

1233

Cooling curve for carbon gun steel

TEMPERATURE IN DEGREES C

TIME IN MINUTES.

FIG. 7.

1234

Cooling curve for nickel steel

the two component systems, iron-carbon. This is the range during which the solid solution or martensite, stable at a temperature above 684 deg. Cent., is transformed into ferrite and pearlite constituents, with less than 0.89 per cent carbon, stable at a temperature below 684 deg. Cent. for this particular steel. Certainly it would not have been difficult to calculate the heat of transformation of this steel, taking into account the weight of the sample and its specific heat. From the transformation range the rate of cooling diminishes, in accordance also with Newton's law. Nickel steel shows also a small point of transformation at 656 deg. Cent., the horizontal not being as well marked as in the curve of the ordinary carbon steel. All that has been said on behalf of this is applicable to ternary nickel steel.

—*Scientific American Supplement.*



## LARGE GUNS

By HENRY BERNAY

Translated from the French by 2nd Lieutenant S. S. Winslow, Coast Artillery Corps, for the Journal U. S. Artillery

It is understood that the new English cruisers of the *Warspite* and *Queen Elizabeth* class, whose keels have just been laid, are to be 27,000-ton ships with a speed of 25 knots, and are to carry a main battery of eight 15-inch guns mounted in four axial turrets. The increase in tonnage, influenced by a desire to develop the offensive qualities to a maximum, continues. The steady increase in calibers, commenced only three years before the laying of the keel of the *Orion*, continues.

When we say "commenced," we really mean "recommenced." The present evolution of the navy ordnance is only a repetition of that of thirty years ago and is brought about by the same causes.

From 1860, the date of the first armored frigate, *La Gloire*, up to about 1880, the struggle between guns and armor was in a very simple form: as the iron plating steadily increased in thickness, presenting more resistance to penetration, the caliber of the guns was increased. Thus they had armor from 17.7 to even 19.6 inches thick, while the caliber of the guns increased to 16.3 inches in England, 16.5 in France, and even to 17 inches in Italy. The ships were overloaded by these enormous guns and tremendous armor, except for which they had many good qualities. But the guns, weighing almost one hundred tons each, were too big and too heavy, and could not be fired oftener than once in five minutes, which made them very ineffective for the offense. The thick armor was only a very weak protection, the ships being vulnerable for most of their length to even the light guns. The weight taken up by the guns and armor was so great that there was little left for the engines and coal supply, so that these ships had neither speed nor wide radius of action and could be used only as coast guards.

The improvements in powder making and the progress in metallurgy, which allowed almost double the bore pressures, marked the beginning of a new era. Thus while the 16.5-inch gun threw a 1764 lb. projectile with an initial velocity of only 1640 feet per second (a velocity attained on board the 18th century sailing vessels), the 12-inch gun, made in 1885, threw a shell weighing only 660 lbs. but with a muzzle velocity of 2625 feet per second.

Since the energy increases very nearly as the square of the velocity, the effect produced remained very nearly the same, in spite of the very perceptible decrease in the weight of the projectile. The new projectile would penetrate a 12-inch plate at a range of 3280 yards. The weight of the guns was decreased by half and the rapidity of fire was doubled at the same time. For the same total weight it was thus possible to have twice as many guns, firing four times as many projectiles, with the same power of penetration.

As the guns were improved, so was the armor. Forged steel, Harveyized steel, and Krupp steel, in turn gave greater resistance for the same thickness. In place of the 20-inch armor of the *Formidable*, they had 12-inch plates, with greater resistance to penetration. The progress in guns continued, and for twenty-five years there was a constant increase in the power of the 12-inch gun, which all navies except the German had adopted as a standard. The Germans held to their 11-inch gun. The shells from the *Jean Bart* weighed 990 lbs., had a muzzle velocity of more than 2950 feet per second, and at a range of 6550 yds, striking at an angle of 20°, would penetrate 13.7 inches of the best steel known.

There appears to be no real reason to exceed a caliber of 12 inches and the French navy does not favor it. The thickest armor on the latest ships is less than 12.5 inches. The 990 lb. shell, containing almost 22 lbs. of melinite, can be exploded after having passed through the armor, where it can do considerable damage. This was shown in our test firings at the *Jena*. It should be remembered that our authorities limited the caliber to 9.45 inches even after the appearance of the first *Dreadnought*. At the same time, working in secret, England was planning the increase which appeared in 1909 in the 13.5-inch guns of the *Orion*.

As has been repeatedly stated, it is very possible that the cause of this modification has been a desire to diminish the pressure and erosion of the gun. In the latest 12-inch guns the metal was tried almost to its limit of resistance. In England muzzles were blown off the guns on several occasions, and there was great erosion in the powder chambers. The 13.5-inch gun of the *Orion* throws a 1270 lb. shell, with a muzzle velocity of only 2800 feet per second. Its 45 instead of 50 calibers of length, makes it very little longer than the 12-inch, and the pressure in the bore is reduced from 42,700 lbs. per square inch to 35,600 lbs. Ballistic advantages of the greatest value are obtained. The 13.5-inch shell, at normal impact at a range of 12,000 yards, will penetrate 11.8 inches of steel. It contains an explosive charge of about 55 lbs., more than double that of the 12-inch. It has greater accuracy on account of its greater weight, and at medium ranges, in glancing shots, gives greater penetration than the lighter shells. Other nations which lack England's vital reason—self protection—for increasing the caliber, can but follow their example, under pain of finding themselves hopelessly inferior. That is why we are designing a 13.4-inch gun, nearly equal to those of the *Orion*, to arm the ships that we laid down in 1912.

Other nations have gone even farther. The United States and Germany have built 14-inch guns, 45 calibers long like the English 13.5, with 1380 pound shells. Their muzzle velocity has remained at about 2600 feet per second. The energy at the muzzle is no greater than for those of the *Orion*, and for long ranges the penetrating power is about the same. The Krupps have already designed a new 14-inch gun, 50 calibers long, with a muzzle velocity of more than 2950 feet per second. England, afraid to be outdone, has continued her work and designed for the *King George* class a new 13.5-

inch gun, 50 calibers long, with a 1400 lb. projectile and a muzzle velocity of 3000 feet per second. This was demanding of the 13.5-inch a power proportional to that of the most powerful 12-inch guns, for the muzzle velocity is

the same and the ratio  $\frac{W}{d^3}$  between the weight of the shell and the cube of the caliber brought the same value.

A series of accidents resulted immediately. Guns were burst and muzzles were blown off in the proving ground tests. It is probable that these accidents are the principal reason for the adoption of the new 15-inch gun, with its 1720 pound projectile, and a somewhat reduced muzzle velocity. As a 1720 pound projectile is relatively light for a 15-inch gun, the pressures cannot approach as near the elastic limit as in the earlier guns. If the ratio  $\frac{W}{d^3}$  were the same as in our *Jean Bart* guns, it would produce a 2000 pound shell.

Beside a search for greater safety, it is very certain that the British Admiralty has adopted these larger guns with the idea of obtaining greater efficiency at long ranges. Range finding instruments have been so greatly improved in these last few years, that under favorable atmospheric conditions the battle can be opened at 11,000 yards, and give as decisive results as could be obtained at 6500 yards, five or six years ago. The 12-inch carries well to 11,000 yards and even beyond, and its accuracy is still great enough to allow good shooting. Its heaviest shell, the 980 pound, at normal impact, will not penetrate more than 8.5 inches of steel at this range. It is not powerful enough for use against either battleships or well armored cruisers under these conditions.

This does not mean that the English, or other nations who fight to destroy their enemy, will do all their fighting at extreme ranges. But it is a great advantage to be able to fight and do your enemy serious damage at these long ranges. It is a still greater advantage if this can be done without getting within range of his guns. Although it now appears difficult to perceptibly increase the thickness of armor, it should be remembered that the metallurgists have not said their last word; and the guns that now seem so all powerful will perhaps be unable to penetrate a new armor that may be developed.

These reasons must have appeared very strong to the British Admiralty to make them, in the ships recently ordered, accept a reduction in the number of pieces, in exchange for an increase of caliber. Since the first *Dreadnought*, all ships have invariably carried ten big guns. The *Warspite* will have but eight, although the total weight allowed the armament will be slightly increased, the weight of the turrets, their protection, and machinery varying as the square of the caliber.

The weight of a broadside, by which the value of ships' armaments are superficially compared, is diminished in spite of the increase in caliber. The *Orion* throws 12,300 pounds of shells in a single broadside, the *King George* and the *Iron Duke* 14,000 pounds—double that of the *Dreadnought* with its 6950 pounds. The *Warspite* throws only 13,700 pounds. But above all, even supposing that the rate of fire of the 12-inch, maintained with the 13.5-inch, can still be kept up with the 15-inch gun, there would yet be only sixteen projectiles per minute in place of twenty, and the difference is perceptible. The English navy must have great confidence in its methods of fire control,

and particularly in the instruments they have installed since their experiments with the *Neptune*, for the decrease in the probable number of shots does not appear to have been considered.

We still believe that the number of shots per minute is an important factor in the effectiveness of the fire of a cruiser. The twelve guns of our *Normandy*, in four turrets, with a maximum field of fire, still appear to give considerable advantages, and their 13.5-inch 1200 pound projectiles seem sufficient against contemporaneous ships. This does not mean that the same influences that are causing the development in England will never cause us to adopt a heavier gun. Our naval artillerists have designed a 14.5-inch gun, and it should be tested without delay. But, for the present, our solution of twelve 13.5-inch guns appears to be superior, from a standpoint of military efficiency, to that of eight 14.5-inch guns, giving the same weight of armament.

—*Le Yacht* (Paris).



### THE ENGLISH BATTLESHIP KING GEORGE V

The *King George V* is the first of the series of four battleships embodying improvements on the *Orion* class.

It is known that the *Orion*, the *Thunderer*, the *Monarch*, and the *Conqueror* pertain to the 1909-1910 program, and have been or soon will be commissioned; that their principal armament consists of ten 13.5-inch, 45-caliber rifles on the center line, and that their displacement is 23,000 tons. Their secondary armament, consisting of ten 4-inch, 50-caliber guns, is entirely without protection.

In order to obtain in the *King George V* class an armament comprising ten large guns arranged in the same manner, but individually more powerful although of the same caliber; in order to protect their secondary armament; and in order to effect various improvements of detail, it has been necessary to increase the displacement to 24,500 tons, normal, and approximately 27,000, full load.

Four battleships, pertaining to the 1910-1911 program, have been built according to this type, all being due to be finished in about two years from the time of laying down. They are: the *King George V*, laid down at Portsmouth in October, 1910, and launched October 9, 1910; the *Centurion*, laid down at Devonport in October, 1910, and launched November 18, 1911; the *Audacious*, laid down at the yards of Cammel and Laird March 23, 1911, and launched September 14, 1912; and the *Ajax*, laid down at the yards of Scott in Glasgow February 27, 1911, and launched April 21, 1912.

The following table gives the official statistics of these ships compared with the *Orion* class, which immediately preceded them, and with the *Iron Duke* class (*Iron Duke*, *Marlborough*, *Benbow*, and *Delhi*, 1911-1912), which immediately follow them:

	Orion	George V	Iron Duke
Displacement	23,000	24,500	25,400
Length between perpendiculars	528.5	555	?
Length over all	584	596	600
Beam	85	89	90
Draught	27¾	27¾	?

	Orion	George V	Iron Duke
Primary armament	10 13.5-inch 45-cal., m IV, proj. 1250 lbs.	10 13.5-inch 45-cal., m V, proj. 1400 lbs.	10 13.5-inch 45-cal., m V, proj. 1400 lbs.
Secondary armament	16 4-inch, unprotected	16 4-inch, protected	14 6-inch, protected
Torpedo tubes	3 21-inch	3 21-inch	3 21-inch
Armor, waterline	12-inch	12-inch	12-inch
turrets			
conning tower			
deck	2¾-inch	2¾-inch	?
Parsons turbines, H.P.	27,000	31,000	33,000
Boilers, Babcock and Yarrow.			

The coal supply, which is the same for the two classes, *Orion* and the *George V*, is 900 tons normal and 2700 maximum. There is also a supply of 1000 tons of oil.

If the construction of the *George V* class is examined, there is found a very marked similarity between it and that of the old *Royal Sovereign* class as well as that of the old *Majestic* class. As with the characteristic productions of Sir. W. White, the armor is reduced at the ends; the primary and the secondary armament grouped in two gun positions (except, of course, the central turret); and the armor is made up of overlapping sections to preserve stiffness.

The thickest armor (12 inches amidships, 4 inches at the ends), protects the waterline; the intermediate, 9 inches, the important between-decks; and the thinnest, 8 inches, the lower deck aft. The 4-inch guns are arranged behind armor plating of thickness equal to their caliber (another of Sir W.-H. White's rules), in two tiers, immediately underneath the second forward turret (four pieces on the upper level between decks; six on the spar-deck; the two or three others, on the upper level, near turret No. 4, aft).

Upon reflection, the English battleship has resumed, or very nearly resumed, the traditional appearance which Sir W.-H. White gave it: its two funnels near the foremast, its turrets on the center line grouped about two main gun positions, one near the end of the first quarter section of the length of the ship, the other near the beginning of the last quarter. The ends, although proportionally for a shorter distance than formerly, are again reduced in armor.

If it is indeed to be believed that the *Iron Duke* class does return to the 6-inch caliber, one must conclude that Sir Philip Watts' later battleships present all the characteristics of Sir. W.-H. White's first, except that their armament is double that of the latter, without their displacement and their armor being double,—thanks to the recognized advantage of very large displacements.

Tripod masts, turrets that fire over others, and turbines are, indeed, only improvements in detail, much admired in theory but still on trial, and it is they, they only, that preserve to the improved *Orion* class a little of the appearance of the original *Dreadnought*.—*Le Yacht* (Paris).

Short Notes

*Austrian Naval Guns.*—The 12-inch guns of the ships of the *Viribus-Unitis* class have the following characteristics: length, 45 calibers; weight of piece, 54.3 tons; weight of projectile, 992 lbs.; and initial velocity, 2625 f.s.  
—*Le Yacht* (Paris).

*British and German Guns.*—The Italian Minister of Marine has laid an interesting report before the Italian Parliament with reference to the armaments of the principal fleets. According to this statement the British, Italian and Japanese Navies are the only ones to mount wirewound guns; the probable life of the Italian and Japanese 12-inch guns is given at 80 rounds, whereas the English gun is credited with being good for only 60 rounds. On the other hand, the Austrian and German guns are given from 200 to 220 rounds, and the American 14-inch gun has a probable life of 150 rounds. The particulars with reference to British and German guns are as follows:—

	British		German		
Caliber in inches.....	12	13.5	12	14	15
Length in calibers .....	50	45	45	50	50
Weight in tons.....	69	80	53	83	102
Weight of projectile in lbs.....	850	1,240	850	1,360	1,650
Initial velocity, f.s. ....	2,950	2,800	3,000	3,000	3,000
Energy at muzzle in metric tons	16,540	22,150	17,520	27,650	33,910
Energy per kilogram in kilometers.....	240	277	330	330	330
Probable life .....	60	60	200	200	200

—*Journal of the Royal United Service Institution.*

*German Naval Guns.*—The German battleships *Kaiserin*, *Konig Albert*, and *Prinzregent Luippold* will be armed with twelve 12-inch and fourteen 5.9-inch guns, and eight torpedo-tubes, and it is understood that the principal guns will be so arranged that all will bear on either broadside. German Dreadnoughts have thus developed along the same general lines as those of the United States, though some two years behind them, successive types having eight, ten, and twelve heavy guns bearing on the beam. Should the comparison continue to hold good, the next German ships should have heavier guns than the 12-inch.—*United Service Magazine.*

*German Naval Guns.*—A new gun of caliber greater than the 12-inch is to be adopted immediately. It will probably be mounted on the ships laid down in 1911: *Ersatz-Weissenburg*, *Ersatz-K.-F. Wilhelm*, and *S*, as well as on the fast cruiser *Kaiserin-Augusta*. Two models have been designed, both fifty calibers: the 14-inch, 69.7-ton gun, throwing a 1367 lb. projectile; and a 15-inch, 85.8-ton gun, throwing a 1675 lb. projectile. (The weight of the projectile of the new English 13.5-inch, Mark VI gun is 1400 lbs.) A 16-inch gun with a projectile weighing 2028 lbs., has been realized by Krupp.

These pieces have been designed in six models: for each caliber there are three lengths—40, 45, and 50 calibers respectively; and of each length there are two types—a light and a heavy, differentiated by their respective weights of powder charge. The weight of projectile remains constant; but the initial velocity varies, for the different models, from 2625 f.s. to 3700



f.s., being about 2950 f.s. for the 50 caliber length, light type, which is the model that will probably be adopted.—*Le Yacht* (Paris).

*New Russian Ships.*—The battleship *Catherine II*, which was laid down last September and which ought to be ready in 1916, is identical with the *Empress Maria*, laid down in November, 1911, and with the *Alexander III*. These ships are like the *Gangut* class, but a little less rapid and of 900 tons smaller displacement: 22,500 tons instead of 23,400, and 21 knots instead of 23. Like the *Gangut* they will carry twelve 12-inch guns in four three-gun turrets on the center line; but, instead of sixteen as on the *Gangut*, they will carry twenty 5.1-inch guns behind armor. They will be provided with four 18-inch torpedo tubes. Their length is 550 feet; their beam, 89.5 feet; and their draft, 27.5 feet. Their fuel supply is 3000 tons.—*Le Yacht* (Paris).

*New French Ships.*—The four battleships to be laid down this year from the French Navy have been named *Normandie*, *Languedoc*, *Flandre*, and *Gascogne*. Two will be laid down in private yards on the 1st May, and two in the dockyards on the 1st October. They will have a displacement of 25,200 tons and a designed speed of 21.5 knots, while the main armament will consist of twelve 13.4-inch guns in three quadruple turrets on the center line. The secondary battery will consist of twenty-four 5.5-inch. Provided the four-gun turret is satisfactory these ships will be of an extremely powerful description. [The armor thickness, according to *Engineer*, is 12.6-inches.]

—*United Service Magazine*.

*New Italian Ships.*—The following are stated, on French authority, to be the details of the Italian battleships *Morosina* and *Dandolo*. Their length will be 590 feet, beam 101.75 feet, and displacement 32,000 tons. The armor belt will be 16 inches thick amidships and 7.9 inches at the ends, while the main turrets will be protected by the former thickness. The designed speed is 25 knots, and the armament will consist of ten 15-inch and fourteen 6-inch guns. The weight of the broadside is given as 17,200 lbs. The principal guns will be mounted on the *Nevada* system—that is, there will be a triple turret forward and aft, with a twin turret superposed behind each.

—*United Service Magazine*.

*Brazilian Battleship Rio de Janeiro.* —The main particulars of the vessels are as follows:

Length between perpendiculars . . . . .	632 ft.
Length over all . . . . .	668 ft.
Breadth . . . . .	89 ft.
Draught . . . . .	27 ft.
Displacement, about . . . . .	27,500 tons
Speed . . . . .	22 knots
Normal coal supply . . . . .	1500 tons
Full coal supply . . . . .	3000 tons

The *Rio* will have the huge complement of about 1100 officers and men.

The main armament will consist of fourteen 12-inch guns, twin mounted in armored turrets. The seven turrets are all on the center line of the ship, and consequently all the 12-inch guns can be trained on one broadside simultaneously. On no other warship up to the present can so many big guns be brought to bear on one broadside, and it is probable that this arrangement



represents the last word in 12-inch gunned ships, as it does not seem likely that any increase beyond fourteen will be contemplated. The broadside fire of the 12-inch guns of the *Rio* will be 11,900 lb., while the ahead and astern fire will be 3400 lb.

The two forward turrets are on the forecastle deck, the second being superposed. The two turrets amidships are also on the forecastle deck, placed back to back, and separated only by the boat derrick. The remaining three turrets are placed on the upper deck aft, the middle one being superposed.

The secondary armament will consist of twenty 6-inch guns, ten 3-inch guns and three 21-inch submerged torpedo tubes. Fourteen of the 6-inch guns will be disposed in single positions, along the upper deck battery behind 6-inch armor, and the remaining six 6-inch guns will have shields. The main armor is to be 9-inches thick in the center tapering down to 4 inches at the ends, and 9 inches is also the thickness of the 12-inch gun barbette armor. There is a conning tower forward, with armor 12 inches thick.

The machinery will consist of Parsons steam turbines working four screws, with Babcock and Wilcox boilers, the furnaces of which are fitted to burn oil fuel as well as coal.—*The Engineer*.

*Japanese Discipline.*—A British officer, an eye-witness, relates the following incident that occurred at a Japanese practice camp. "The breech of a gun was blown out on the 3rd September, one gunner was killed on the spot, and six non-commissioned officers and men as well as the section commander were wounded. *The wounded men at once returned to their places at the gun and endeavored to go on with their duties as if nothing had happened.*"

—*Journal of the Royal United Service Institution.*

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## NOTICES

### MILITARY INVENTIONS

#### RECENT U. S. PATENTS OF MILITARY INTEREST

A complete copy of any patent here listed may be obtained of H. B. Willson & Co., Patent Attorneys, 715 Eighth St., N. W., Washington, D. C. Enquirers should indicate patent number and remit ten cents.

#### AERONAUTICS

- 1,055,245 Air-Anchor for Parachutes, Jean F. Webb, New York, N. Y.
- 1,053,182 Parachute Carrying and Disengaging Means, Carried by an Aeroplane and Attached Thereto, Antony Jannus and Thos. W. Benoist, St. Louis, Mo.
- 1,052,199 Automatic Balancing and Horizontal Sustaining Aeroplane, Geo. B. N. Austin, Melbourne, Victoria, Australia.
- 1,051,093 Aerial Trolley-Car, Jos. W. Fawkes and Emma C. Fawkes, Burbank, Cal.
- 1,050,573 Buoyancy-Indicator, Geo. A. Spratt, Coatesville, Pa.

#### ARTILLERY

- 1,055,032 Gun House for Use in Warships, Forts, and the Like, Robert A. Hadfield, Sheffield, England.

- 1,054,514 Mechanism for Automatically Firing Guns, G. E. Dietzel, Dusseldorf, Ger., Assignor to Rheinische Metallwaaren-und Maschinenfabrick, Dusseldorf-Derendorf, Germany.

## EXPLOSIVES

- 1,054,049 Method of Casting Explosive Charges, Ernst Sokolowski, Hamburg, Ger., Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del.
- 1,054,147 Cast Explosive Charge, Ernst Sokolowski, Hamburg, Ger., Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del.
- 1,052,606 Bomb for Use with Aeroplanes and other Flying Machines, H. S. Maxim, Streatham, London, England, Assignor to Vickers Ltd., Westminster, Eng.
- 1,053,165 Safety Supply-Box and Powder-Magazine, Thomas Doyle, Eldorado, Ill.
- 1,053,878 Storage Plant for Explosive Liquids, Arthur Sachsse, New York, N. Y.

## SHIPS (NAVAL), ARMOR, ETC.

- 1,050,090 Blade or Fish-Tail Propeller and Submarine Boat, Guido Antoni and Ugo Antoni, Pisca, Italy.

## SIGNALLING

- 1,051,543 Direction-Finder for Submarine Signals, Lucien Ira Blake, London, Eng.

## SMALL ARMS, TARGETS, ETC.

- 1,052,316 Combined Firearm and Sword, John Cihucki, Shenandoah, Pa.
- 1,055,416 Automatic Bayonet, Jno. D. Pliones and P. G. Collias, Berkeley, Cal.
- 1,051,032 Single-Trigger Mechanism for Double-Barreled Guns, C. B. Tilden, Madison, Ohio, Assignor to Willis A. Sunderland, Madison, Ohio.

## MISCELLANEOUS

- 1,054,253 Folding Spy-Glass, Louis C. Stuart, Kans. City, Mo., Assignor to Susan Lindsey, Parsons, Kans.
- 1,055,772 Ammunition-Wagon, Wilhelm Mayer, Essen-on-the-Ruhr, Ger., Assignor to Fried. Krupp Aktiengesellschaft, Essen-on-the-Ruhr, Germany.
- 1,051,413 Electrical Conduction System for Communicating Electrical Energy, G. H. Pickard, Amesbury, Mass., Assignor to Wireless Specialty Apparatus Co., New York, N. Y.
- 1,051,042 Military Multiple-Purpose Spade, Clarence Wiener, Philadelphia, Pa.
- 1,051,056 Levitating Apparatus for Conveying Ammunition, etc., Emile Bachelet, Mount Vernon, N. Y., Assignor to M. R. Bracewell, North Adams, Mass.

## BOOK REVIEWS

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**The Soldier's Foot and the Military Shoe.** By Major E. L. Munson, Medical Corps, U. S. A. Fort Leavenworth, Kansas: U. S. Cavalry Association, Agents. 6¼" x 9¼". 147 pp. 54 il. Cloth. 1912. Price, \$1.35 postpaid.

This book is the result of extensive study and experiment, and embodies in convenient form and sequence the necessary information for the proper fitting and wearing of shoes.

While intended for the military service, it is difficult to imagine any one to whom it would not be of use, and, perhaps, of interest. It is a convincing argument in favor of the design of the new marching shoe; and if that shoe is constructed, fitted, and worn as prescribed, the marching capacity of our army should be materially increased. If the book succeeds in arousing among line officers, in the homely subject of soldiers' feet, an interest similar to that which has existed in the mounted service in horses' feet, it will have served a great purpose.

A good use of the book would be as a series of lectures by company commanders to their men; for a few hours so spent must result in an improved understanding of the importance of the subject as well as in an acquaintance with the simple rules of care.

The book contains eight chapters, the contents being as follows:

- I. Foot injuries and marching capacity;
- II. The anatomy and use of the foot;
- III. The military shoe;
- IV. The fitting of military shoes;
- V. Shoe supply;
- VI. The care of the feet;
- VII. The sock;
- VIII. The care of the shoes.

However homely the subject, it has a direct bearing on the fighting efficiency of troops; hence a thorough knowledge of it is essential. One wonders why the problem was not worked out a couple of hundred years ago.



**Der Kampf um Sperrbefestigungen im Landkriege.** (The Attack and Defense of Barrier Forts in Land Warfare. For Officers of all Arms.) By W. Stavenhagen, Königlich Preussischen Hauptmann a. D. Berlin: Ernst Siegfried Mittler und Sohn, Königl. Hofbuchhandlung, Kochstrasse 68-71. 6¼" x 9¼". 62 pp. Paper. Price, M1.50.

That fortification has often exercised a most potent influence on the course of an entire war, and none the less so as a result of modern conditions of warfare, is abundantly proved by the most recent events of history. In his preface Captain Stavenhagen recalls numerous examples from the wars of the last and the present century which evidence the influence of fortress

warfare on the course of a whole war. Notable among them is the defense of Port Arthur, and above all, the rôle being played by fortification in the present war in the Balkans, where the Bulgarians have been checked in their impetuous rush on Constantinople by the line of barrier forts at Tchatalja, and where the fortress of Adrianople has defied all efforts to reduce or capture it. It is with these facts in mind that the author has added this interesting and most modern contribution to the literature on fortification, with the intention of superseding his previous writings on the subject.

Barrier forts, which are defined as independent works defendable on all sides, sometimes appearing as isolated armored units, but frequently as groups of works in line protecting the country behind them from sudden invasion, will undoubtedly be factors of importance in future wars. Their primary function is to deny to the enemy and to preserve for one's own use means of communication such as railroads, mountain passes, bridges, etc.

The organization and equipment of the forces required to attack such a position successfully is first inquired into, and the artillery, especially the foot artillery, seems called upon to play the most important rôle in the attack. The necessity for heavy howitzers and mortars is emphasized. In a few words, there should be sufficient artillery superiority to silence and to keep silenced the artillery of the fort and adjacent works, if any, while the engineers remove obstacles, and the infantry press forward, and prepare for the final assault—an undertaking that has a greater chance of success against isolated units than would be the case with mutually supporting works. Other subjects considered in this connection are the choice of the front of attack, reconnaissance by airships, etc., telegraph and other means of communication, searchlights, and every conceivable detail down to the individual equipment of the assaulting troops.

Equally careful study of the organization, armament, and *modus operandi* of the defense completes this work; while a number of appendices contain information as to the procedure in case regular approaches have to be resorted to in the attack, as well as a description of the Krupp heavy artillery and that of foreign countries.



**Explosives - A Synoptic and Critical Treatment of the Literature on the Subject as Gathered from Various Sources.** By Dr. H. Brunswig. Translated and Annotated by Chas. E. Munroe and Alton L. Kibler. New York City: John Wiley and Sons, 13 East 19th Street. 5¾" x 8¼". XV + 350 pp. 15 il. Cloth. 1912. Price, \$3.00.

In the field of explosives, the labor of scientist and technologist during the past twenty or thirty years has resulted in the accumulation of a large amount of experimental data which has not heretofore been examined through the application of physical chemistry. All recent developments indicate that the chemistry of explosives is really a physical-chemical science, dealing with the velocities of chemical reactions and chemical equilibria at high temperatures and pressures; and that the investigation of phenomena observed in explosive processes must be conducted from this standpoint, in order that the results may be properly interpreted.

Dr. Brunswig, as is stated in the Preface, has gathered together the facts recorded in the literature of explosives, arranging them in accordance with

physical-chemical views, and has added a general survey of the chemistry of explosives and its most important aims.

The work is divided into ten chapters as follows:

- Chapter I. General Behavior of Explosive Systems.
- " I. Velocity of Explosive Reactions.
- " III. Explosions Pressure.
- " IV. Temperature of Explosions.
- " V. Gases from Explosive Reactions.
- " VI. Explosions by Influence.
- " VII. Flame of an Explosion.
- " VIII. Characteristics of Particular Explosives.
- " IX. Propellants.
- " X. Blasting Explosives.

An idea of the scope of the work may be gained by an examination of one of the chapters. In Chapter II, under "Velocity of Explosive Reactions," after a general preliminary discussion, there is first taken up the initial velocity of reactions, the influence of pressure and temperature and the effect of catalytic influences being set forth and illustrated by the experiments of such authorities as Berthelot, Vieille, Le Chatelier, Van't Hoff, and others. Next the velocity of propagation of explosive reactions is considered, the various experiments upon which the stated principles are based, being cited. In this case also, the effects of temperature, pressure, and catalytic influences are well presented. The chapter closes with a discussion of explosion waves and various theories advanced relative thereto.

The other chapters show a similar thorough and comprehensive treatment of the subject. The material in each chapter is well arranged, concise, and clearly stated; and, all theoretical mathematical discussions being omitted, the non-mathematical reader has no difficulty in following the statements of the author.

Copious references are given, usually as foot-notes, so that the original researches on any subject can easily be found. And the unusually complete table of contents, the authors index, and the subject index, contribute to make the contents of the book exceptionally accessible.

In general, it may be said that this work constitutes a valuable addition to the comparatively meager literature on the subject of explosives, and it cannot but prove a most useful addition to the library of the student or the technologist.

# KEY TO INDEX TO CURRENT MILITARY LITERATURE

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The periodicals cited are arranged by government, and each periodical is assigned a symbol consisting of an initial, or other abbreviation of the governmental designation, and a numeral indicative of the periodical's position in an alphabetical arrangement of the Journal of the United States Artillery's exchanges under that government.

Prices of subscription are given in the currencies of the countries of publication.

All the periodicals cited are preserved in the Library of the Coast Artillery School at Fort Monroe, Virginia.

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## ARGENTINE

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|---------------|--|--|
| <i>Ar-0.5</i> | <i>Anuario del Instituto Geografico Militar de la Republica Argentina</i><br>3ª Division del Estado Mayor del Ejército<br>Buenos Aires | Annual   |
| <i>Ar-1</i>   | <i>Boletin del Centro Naval</i><br>Florida 659, Buenos Aires   | Bimonthly<br>Per year \$ <sup>m</sup> / <sub>n</sub> 11.90 |
| <i>Ar-1.5</i> | <i>Revista del Circulo Militar</i><br>255 Maipu<br>Buenos Aires  | Monthly<br>Per year \$12.00                                |
| <i>Ar-2</i>   | <i>Revista Militar</i><br>Ministerio de Guerra, Santa Fe 1461<br>Buenos Aires  | Monthly<br>Per year \$ <sup>m</sup> / <sub>n</sub> 9.00    |

## AUSTRIA

- |             |   |                          |
|-------------|---|--------------------------|
| <i>Au-1</i> | <i>Mitteilungen aus dem Gebiete des Seewesens</i><br>Pola   | Monthly<br>Per year 17 M |
| <i>Au-2</i> | <i>Mitteilungen ueber Gegenstaende des Artillerie-und Genie-Wesens</i><br>Getreidemarkt 9<br>Wien, VI.                    | Monthly<br>Per year 20 M |
| <i>Au-3</i> | <i>Streffleurs Militaerische Zeitschrift zugleich Organ der militaerwissenschaftlichen Vereine</i><br>I. Graben, 13. Wien | Monthly<br>Per year 28 M |
| <i>Au-4</i> | <i>Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines</i><br>I. Eschenbachgasse, No. 9<br>Wien          | Weekly<br>Per year 34 K  |

## BELGIUM

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|-------------|--|-----------------------------|
| <i>Be-1</i> | <i>Belgique Militaire, La</i><br>Rue Albert de Latour 50<br>Schaerbeek, Brussels | Weekly<br>Per year 12 fr 50 |
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<i>Be-2</i>	<i>Revue de l'Armée Belge</i> 24 Rue des Guillemins, Liege	Bimonthly Per year 13 fr
<i>Be-3</i>	<i>Revue de l'Ingénieur et Index Technique</i> 70, Boulevard d'Anderlecht, Brussels	Monthly Per year 30 fr

## BRAZIL

<i>Br-1</i>	<i>Boletim Mensal do Estado Maior do Exercito</i> Ministerio de Guerra Rio de Janeiro	Monthly
<i>Br-2</i>	<i>O Tiro</i> Rio de Janeiro	Bimonthly
<i>Br-3</i>	<i>Revista Maritima Brasileira</i> Rua D. Manoel n. 15 Rio de Janeiro	Monthly Per year 12\$000

## CHILE

<i>C-1</i>	<i>Memorial del Estado Mayor del Ejercito de Chile</i> Talleres del Estado Mayor-General Santiago	Monthly
<i>C-2</i>	<i>Revista de Marina</i> Casilla del Correo 976, Valparaiso	Monthly Per year \$15.00

## COLUMBIA

<i>Co-1</i>	<i>Memorial del Estado Mayor del Ejercito de Colombia</i> Jefe del Departamento de Historia del Estado Mayor-General Bogota	Bimonthly Per year \$0 50 oro
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## DENMARK

<i>D-1</i>	<i>Militært Tidsskrift</i> Copenhagen	Semimonthly Per year 8 kr
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## FRANCE

<i>F-1</i>	<i>Archives Militaires</i> Librairie Militaire Berger-Levrault 5-7 Rue des Beaux-Arts, Paris	Quarterly Per year 14 fr
<i>F-2</i>	<i>France Militaire, La</i> 10 Rue Danton, Paris	Daily Per year 32 fr
<i>F-3</i>	<i>Génie Civil, Le</i> 6 Rue de la Chaussée d'Antin, Paris	Weekly Per year 45 fr
<i>F-4</i>	<i>Journal des Sciences Militaires</i> 30 Rue et Passage Dauphine (VI") Paris	Semimonthly Per year 40 fr
<i>F-5</i>	<i>Liste Navale Francaise</i> Quai Cronstadt, au coin de la Rue Neuve Toulon	Quarterly Per year 9 fr
<i>F-6</i>	<i>Memoires et Travaux de la Société des Ingénieurs Civils</i> 19 Rue Blanche Paris	Monthly Per year 36 fr
<i>F-7</i>	<i>Memorial des Poudres et Salpetres</i> 55 Quai des Grands-Augustins, Paris	Semiannually Per year 13 fr

<i>F-8</i>	<i>Mois Scientifique et Industriel, Le</i> 8, Rue Nouvelle, Paris	Monthly Per year 25 fr
<i>F-9</i>	<i>Monde Militaire, Le</i> 6 Rue de la Chaise, Paris	Fortnightly Per year 6 fr
<i>F-10</i>	<i>Revue d'Artillerie</i> 5 Rue des Beaux-Arts, Paris	Monthly Per year 22 fr
<i>F-11</i>	<i>Revue de Cavalerie</i> 5 Rue des Beaux-Arts, Paris	Monthly, ex. Aug. Per year 27 fr
<i>F-12</i>	<i>Revue du Génie Militaire</i> 5 Rue des Beaux-Arts, Paris	Monthly Per year 27 fr
<i>F-13</i>	<i>Revue d'Infanterie, La</i> 10 Rue Danton, Paris	Monthly Per year 25 fr
<i>F-13.5</i>	<i>Revue de l'Aviation de l'Automobile et des Sports, La</i> 3, Avenue de l'Opéra, Paris	Monthly Per year 18 fr
<i>F-14</i>	<i>Revue Maritime</i> 30 Rue et Passage Dauphine, Paris	Monthly Per year 36 fr
<i>F-15</i>	<i>Revue Militaire des Armées Etrangères</i> Librairie Chapelot 30 Rue et Passage Dauphine, Paris	Monthly Per year 15 fr
<i>F-16</i>	<i>Yacht, Le, Journal de la Marine</i> 55 Rue Chateaudun, Paris	Weekly Per year 32 fr

## GERMANY

<i>G-1</i>	<i>Artilleristische Monatshefte</i> Mohrenstr. 19, Berlin, W. 8	Monthly Per year 27 M
<i>G-2</i>	<i>Eisen-Zeitung</i> Verlag von Otto Elsner, Berlin, S. 42	Weekly Per year 12 M
<i>G-3</i>	<i>Ingenieur, Der</i> Cordel & Renné Fritschestr. 47, Charlottenburg 4	Semimonthly Per year 16 M
<i>G-4</i>	<i>Marine Rundschau</i> Koch Strasse, 68-71, Berlin, S.W.	Monthly Per year 10 M
<i>G-5</i>	<i>Militaer Wochenblatt</i> With monthly Supplement Koch Strasse, 68, Berlin, S.W., 12	3 times a week Per year 18 M
<i>G-6</i>	<i>Schiffbau</i> Zimmerstr. 9, Berlin, S.W., 68	Semimonthly Per year 20 M
<i>G-8</i>	<i>Ueberall</i> Verlag: Boll und Pickardt Berlin, N.W. 7	Monthly Per year 15.6 M
<i>G-9</i>	<i>Zeitschrift fuer das Gesamte Schiess-und Sprengstoffwesen</i> J. F. Lehmann's Verlag, Munich	Semimonthly Per year 26 M

## HOLLAND

<i>H-1</i>	<i>Organ of the Association for the Study of Military Science</i> Z. O. Buitsensingel 223 The Hague	Yearly Per year 2 florins
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## ITALY

<i>I-1</i>	<i>Lista Navale Italiana</i> Officina Poligrafica Italiana, Rome	Quarterly Per year 15 L
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<i>Be-2</i>	<i>Revue de l'Armée Belge</i> 24 Rue des Guillemins, Liege	Bimonthly Per year 13 fr
<i>Be-3</i>	<i>Revue de l'Ingénieur et Index Technique</i> 70, Boulevard d'Anderlecht, Brussels	Monthly Per year 30 fr

## BRAZIL

<i>Br-1</i>	<i>Boletim Mensal do Estado Maior do Exercito</i> Ministerio de Guerra Rio de Janeiro	Monthly
<i>Br-2</i>	<i>O Tiro</i> Rio de Janeiro	Bimonthly
<i>Br-3</i>	<i>Revista Maritima Brasileira</i> Rua D. Manoel n. 15 Rio de Janeiro	Monthly Per year 12\$000

## CHILE

<i>C-1</i>	<i>Memorial del Estado Mayor del Ejercito de Chile</i> Talleres del Estado Mayor-General Santiago	Monthly
<i>C-2</i>	<i>Revista de Marina</i> Casilla del Correo 976, Valparaiso	Monthly Per year \$15.00

## COLUMBIA

<i>Co-1</i>	<i>Memorial del Estado Mayor del Ejercito de Colombia</i> Jefe del Departamento de Historia del Estado Mayor-General Bogota	Bimonthly Per year \$0 50 oro
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## DENMARK

<i>D-1</i>	<i>Militært Tidsskrift</i> Copenhagen	Semimonthly Per year 8 kr
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## FRANCE

<i>F-1</i>	<i>Archives Militaires</i> Librairie Militaire Berger-Levrault 5-7 Rue des Beaux-Arts, Paris	Quarterly Per year 14 fr
<i>F-2</i>	<i>France Militaire, La</i> 10 Rue Danton, Paris	Daily Per year 32 fr
<i>F-3</i>	<i>Génie Civil, Le</i> 6 Rue de la Chaussée d'Antin, Paris	Weekly Per year 45 fr
<i>F-4</i>	<i>Journal des Sciences Militaires</i> 30 Rue et Passage Dauphine (VI°) Paris	Semimonthly Per year 40 fr
<i>F-5</i>	<i>Liste Navale Francaise</i> Quai Cronstadt, au coin de la Rue Neuve Toulon	Quarterly Per year 9 fr

F-6	<i>Memoires et Travaux de la Société des Ingénieurs Civils</i> 19 Rue Blanche Paris	Monthly Per year 36 fr
F-7	<i>Memorial des Poudres et Salpêtres</i> 55 Quai des Grands-Augustins, Paris	Semiannually Per year 13 fr
F-8	<i>Mois Scientifique et Industriel, Le</i> 8, Rue Nouvelle, Paris	Monthly Per year 25 fr
F-9	<i>Monde Militaire, Le</i> 6 Rue de la Chaise, Paris	Fortnightly Per year 6 fr
F-10	<i>Revue d'Artillerie</i> 5 Rue des Beaux-Arts, Paris	Monthly Per year 22 fr
F-11	<i>Revue de Cavalerie</i> 5 Rue des Beaux-Arts, Paris	Monthly, ex. Aug. Per year 27 fr
F-12	<i>Revue du Génie Militaire</i> 5 Rue des Beaux-Arts, Paris	Monthly Per year 27 fr
F-13	<i>Revue d'Infanterie, La</i> 10 Rue Danton, Paris	Monthly Per year 25 fr
F-14	<i>Revue Maritime</i> 30 Rue et Passage Dauphine, Paris	Monthly Per year 36 fr
F-15	<i>Revue Militaire des Armées Etrangères</i> Librairie Chapelot 30 Rue et Passage Dauphine, Paris	Monthly Per year 15 fr
F-16	<i>Yacht, Le, Journal de la Marine</i> 55 Rue Chateaudun, Paris	Weekly Per year 32 fr

## GERMANY

G-1	<i>Artilleristische Monatshefte</i> Mohrenstr. 19, Berlin, W. 8	Monthly Per year 27 M
G-2	<i>Eisen-Zeitung</i> Verlag von Otto Elsner, Berlin, S. 42	Weekly Per year 12 M
G-3	<i>Ingenieur, Der</i> Cordel & Renné Fritschestr. 17, Charlottenburg 4	Semimonthly Per year 16 M
G-4	<i>Marine Rundschau</i> Koch Strasse, 68-71, Berlin, S.W.	Monthly Per year 10 M
G-5	<i>Militaer Wochenblatt</i> With monthly Supplement Koch Strasse, 68, Berlin, S.W., 12	3 times a week Per year 18 M
G-6	<i>Schiffbau</i> Zimmerstr. 9, Berlin, S.W., 68	Semimonthly Per year 20 M
G-8	<i>Ueberall</i> Verlag: Boll und Pickardt Berlin, N.W. 7	Monthly Per year 15.6 M
G-9	<i>Zeitschrift fuer das Gesamte Schiess-und Sprengstoffwesen</i> J. F. Lehmann's Verlag, Munich	Semimonthly Per year 26 M

## HOLLAND

H-1	<i>Organ of the Association for the Study of Military Science</i> Z. O. Buitsensingel 223 The Hague	Yearly Per year 2 florins
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<b>UK-13</b>	<b><i>Journal of the Royal United Service Institution</i></b> Whitehall, London, S.W.	<b>Monthly</b> <b>Per year 24s</b>
<b>UK-14</b>	<b><i>Journal of the United Service Institution of India</i></b> Simla, India	<b>Quarterly</b> <b>Per year Rs 8</b> <b>Single copy 1s</b>
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<b>UK-18</b>	<b><i>Photographic Journal</i></b> 35 Russell Square, London	<b>Occasional</b> <b>Copies 1s each</b>
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<b>UK-20</b>	<b><i>Proceedings of the Institution of Mechanical Engineers</i></b> Story's Gate St., James Park, London, S. W.	
<b>UK-21</b>	<b><i>Royal Engineers Journal, The</i></b> Chatham	<b>Monthly</b> <b>Per year 15s</b>
<b>UK-22</b>	<b><i>Transactions of the Canadian Institute</i></b> 58 Richmond Street, Toronto, Canada	
<b>UK-23</b>	<b><i>Transactions of the Canadian Society of Civil Engineers</i></b> 176 Mansfield Street Montreal, Canada	
<b>UK-24</b>	<b><i>Transactions of the Institution of Naval Architects</i></b> 5 Adelphi Terrace, London, W. C.	
<b>UK-25</b>	<b><i>United Service Gazette</i></b> 43, 44 Temple Chambers London, E. C.	<b>Weekly</b> <b>Per year £1 10s 6d</b>
<b>UK-26</b>	<b><i>United Service Magazine</i></b> 23 Cockspur Street, Charing Cross London, S. W.	<b>Monthly</b> <b>Per year £1 1s</b>

## UNITED STATES

<b>US-1</b>	<b><i>Aeronautics</i></b> 122 East 25th Street, New York City	<b>Monthly</b> <b>Per year \$3.00</b>
<b>US-2L</b>	<b><i>American Historical Review</i></b> The Macmillan Company 41 N. Queen Street, Lancaster, Pa., or 66 Fifth Avenue, New York City	<b>Quarterly</b> <b>Per year \$4.00</b>
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<b>US-4</b>	<b><i>American Journal of Mathematics</i></b> Johns Hopkins Press Baltimore, Md.	<b>Quarterly</b> <b>Per year \$5.00</b>
<b>US-5</b>	<b><i>Arms and The Man</i></b> 1502 H Street, N.W., Washington, D. C.	<b>Weekly</b> <b>Per year \$3.00</b>
<b>US-6</b>	<b><i>Army and Navy Journal</i></b> 20 Vesey Street, New York	<b>Weekly</b> <b>Per year \$6.00</b>
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## SPAIN

<i>Sp-1</i>	<i>Informacion Militar del Extranjero</i> Madrid	Monthly
<i>Sp-2</i>	<i>Memorial de Artilleria</i> Museo de Artilleria, Madrid	Monthly Per year 18 ps
<i>Sp-3</i>	<i>Revista Cientifico-Militar</i> Paseo de San Juan, 201, Barcelona	Semimonthly Per year 40 ps
<i>Sp-4</i>	<i>Revista General de Marina</i> Ministerio de Marina, Madrid	Monthly Per year 25 ps

## SWEDEN

<i>Sn-1</i>	<i>Artilleri-Tidsskrift</i> Artillerigarden, Stockholm	Bimonthly Per year 6 kr
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## SWITZERLAND

<i>Sd-1</i>	<i>Allgemeine Schweizerische Militaer-Zeitung</i> Basel	Weekly Per year 10 fr
<i>Sd-2</i>	<i>Revue Militaire Suisse</i> Avenue Juste Olivier, Lausanne	Monthly Per year 15 fr
<i>Sd-3</i>	<i>Schweizerische Monatschrift fuer Offiziere Aller Waffen</i> Frauenfeld	Monthly Per year 5 fr
<i>Sd-4</i>	<i>Schweizerische Zeitschrift fuer Artillerie und Genie</i> Frauenfeld	Monthly Per year 8 fr

UNITED KINGDOM OF GREAT BRITAIN AND IRELAND  
ITS COLONIES AND POSSESSIONS

<i>UK-1</i>	<i>Arms and Explosives</i> Effingham House Arundel Street, Strand, London, W.C.	Monthly Per year 7s
<i>UK-2</i>	<i>Army and Navy Gazette</i> 22 Essex Street, Strand London, W.C.	Weekly Per year £1 12s 6d
<i>UK-3</i>	<i>Army Review, The</i> Wyman & Sons, Ltd. Fetter Lane, London, E. C.	Quarterly Per copy 1s
<i>UK-4</i>	<i>Canadian Military Gazette</i> Room 16, Trust Bldg. Ottawa, Canada	Semimonthly Per year \$2.50
<i>UK-5</i>	<i>Commonwealth Military Journal, The</i> Melbourne, Australia	Monthly
<i>UK-6</i>	<i>Electrician, The</i> 1, 2 and 3, Salisbury Court, Fleet Street London	Weekly Per year 30s
<i>UK-7</i>	<i>Electrical Review</i> 4, Ludgate Hill, London, E. C.	Weekly Per year £1 10s

UK-8	<i>Engineer, The</i> 33 Norfolk Street, Strand London, W.C.	Weekly Per year £1 16s
UK-9	<i>Engineering</i> 35-36 Bedford Street, Strand London, W.C.	Weekly Per year £1 16s
UK-10	<i>Iron &amp; Coal Trades Review, The</i> 165 Strand, London, W. C.	Weekly Per year 27s
UK-11	<i>Journal of the Royal Artillery, The</i> Woolwich	Monthly Single copy 2s 6d
UK-12	<i>Journal and Proceedings, Royal Society N. S. W.</i> 5 Elizabeth St., North Sydney, N. S. W.	
UK-13	<i>Journal of the Royal United Service Institution</i> Whitehall, London, S.W.	Monthly Per year 24s
UK-14	<i>Journal of the United Service Institution of India</i> Simla, India	Quarterly Per year Rs 8 Single copy 1s
UK-15	<i>Junior Institution of Engineers, The</i> 39 Victoria St., Westminster, S.W. London	
UK-17	<i>Page's Weekly</i> 22 Henrietta Street, Covent Garden London, W. C.	Weekly Per year £1 5s
UK-18	<i>Photographic Journal</i> 35 Russell Square, London	Occasional Copies 1s each
UK-19	<i>Proceedings of the Institution of Civil Engineers</i> Great George St., Westminster, London, S. W.	
UK-20	<i>Proceedings of the Institution of Mechanical Engineers</i> Story's Gate St., James Park, London, S. W.	
UK-21	<i>Royal Engineers Journal, The</i> Chatham	Monthly Per year 15s
UK-22	<i>Transactions of the Canadian Institute</i> 58 Richmond Street, Toronto, Canada	
UK-23	<i>Transactions of the Canadian Society of Civil Engineers</i> Montreal, Canada	
UK-24	<i>Transactions of the Institution of Naval Architects</i> 5 Adelphi Terrace, London, W. C.	
UK-25	<i>United Service Gazette</i> 43, 44 Temple Chambers London, E. C.	Weekly Per year £1 10s 6d
UK-26	<i>United Service Magazine</i> 23 Cockspur Street, Charing Cross London, S. W.	Monthly Per year £1 1s

## UNITED STATES

US-1	<i>Aeronautics</i> 122 East 25th Street, New York City	Monthly Per year \$3.00
US-2L	<i>American Historical Review</i> The Macmillan Company 41 N. Queen Street, Lancaster, Pa., or 66 Fifth Avenue, New York City	Quarterly Per year \$4.00

US-3L	<i>American Journal of International Law, The</i> Baker, Voorhis & Co., 45 John St., N.Y.	Quarterly Per year \$5.00
US-4	<i>American Journal of Mathematics</i> Johns Hopkins Press Baltimore, Md.	Quarterly Per year \$5.00
US-5	<i>Arms and The Man</i> 1502 H Street, N.W., Washington, D. C.	Weekly Per year \$3.00
US-6	<i>Army and Navy Journal</i> 20 Vesey Street, New York	Weekly Per year \$6.00
US-7	<i>Army and Navy Register</i> Washington, D. C.	Weekly Per year \$3.00
US-8	<i>Bulletin of the American Geographical Society</i> Broadway at 156th Street, New York City	Monthly Per year \$5.00
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US-11	<i>Bulletins and Circulars of the Bureau of Standards</i> Department of Commerce and Labor Washington, D. C.	
US-12L	<i>Bulletin of the Pan American Union</i> Seventeenth and B Streets, N.W. Washington, D. C.	Monthly Per year \$2.00
US-13	<i>Bulletin Iowa State College</i> Ames, Iowa	Monthly
US-14	<i>Bulletin of the University of Illinois</i> Urbana, Illinois	
US-15	<i>Bulletins, Circulars and Technical Papers</i> <i>Bureau of Mines</i> Department of the Interior Washington, D. C.	Occasional Free
US-16L	<i>Canal Record</i> Ancon, Canal Zone, Isthmus of Panama	Weekly Per copy 5c
US-17	<i>Cassier's Magazine</i> 12 West 31st Street, New York	Monthly Per year \$3.00
US-17.5	<i>Colliery Engineer, The</i> Scranton, Pa.	Monthly Per year \$2.00
US-18	<i>Compressed Air Magazine</i> Compressed Air Magazine Co. Easton, Pa.	Monthly Per year \$1.50
US-19	<i>Confederate Veteran</i> Nashville, Tenn.	Monthly Per year \$1.00
US-20	<i>Craftsman, The</i> 41 W. 34th Street, New York	Monthly Per year \$3.00
US-21	<i>Electric Journal, The</i> 200 Ninth Street, Pittsburgh, Pa.	Monthly Per year \$1.50
US-22	<i>Electrical Review and Western Electrician</i> Heisen Building 608 South Dearborn Street, Chicago	Weekly Per year \$3.00
US-23	<i>Electrical World</i> 239 West 39th Street, New York	Weekly Per year \$3.00

US-24	<i>Engineering Magazine, The</i> 140-142 Nassau Street, New York	Monthly Per year \$3.00
US-25	<i>Engineering News</i> 505 Pearl Street, New York	Weekly Per year \$5.00
US-26	<i>Engineering Record</i> 239 West 39th Street, New York	Weekly Per year \$3.00
US-27	<i>Field Artillery Journal, The</i> U. S. Field Artillery Association 1701 Pennsylvania Avenue, N.W. Washington, D.C.	Quarterly Per year \$4.00
US-28	<i>Flying and The Aero Club of America Bulletin</i> 297 Madison Ave., New York	Monthly Per year \$3.00
US-29	<i>General Electric Review</i> General Electric Company Schenectady, New York	Monthly Per year \$2.00
US-30	<i>Infantry Journal</i> U. S. Infantry Association 814 Seventeenth Street, N.W. Washington, D. C.	Bi-monthly Per year \$3.00
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US-33	<i>Journal of The American Society of Mechanical Engineers, The</i> 29 West 39th Street, New York City	Monthly Per year \$3.00
US-34	<i>Journal of the American Society of Naval Engineers</i> Navy Department, Washington, D.C.	Quarterly Per year \$5.00
US-35	<i>Journal of the Association of Engineering Societies</i> 31 Milk Street Boston, Mass.	Monthly Per year \$3.00
US-36	<i>Journal of the Franklin Institute</i> 15 South Seventh Street, Philadelphia, Pa.	Monthly Per year \$5.00
US-37	<i>Journal of the Military Service Institution</i> Governor's Island, New York	Bi-monthly Per year \$3.00
US-38	<i>Journal of the U. S. Artillery</i> Fort Monroe, Virginia	Bi-monthly Per year \$2.50
US-39	<i>Journal of the U. S. Cavalry Association</i> Fort Leavenworth, Kansas	Bi-monthly Per year \$2.50
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US-45L	<i>National Geographic Magazine, The</i> Hubbard Memorial Hall Washington, D. C.	Monthly Per year \$2.50
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US-48	<i>Official Gazette of the United States Patent Office, The</i> Supt. of Documents, Gov. Printing Office Washington, D. C.	Weekly Per year \$5.00
US-49	<i>Pennsylvania Magazine of History and Biography</i> Philadelphia, Pa.	Quarterly Per year \$3.00
US-50	<i>Physical Review</i> 41 North Queen Street, Lancaster, Pa.	Monthly Per year \$6.00
US-51	<i>Polytechnic, The</i> Troy, N. Y.	10 Nos. per yr. Per year \$2.00
US-52	<i>Popular Mechanics</i> 318 West Washington Street, Chicago, Ill.	Monthly Per year \$1.50
US-53	<i>Practical Electricity and Engineering</i> 608 South Dearborn Street, Chicago, Ill.	Monthly Per year \$1.00
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<b>US-68</b>	<b><i>Seventh Regiment Gazette, The</i></b> 30 West 33rd Street, New York	<b>Monthly</b> <b>Per year \$1.50</b>
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 The Indian medical service—US-43, April, 13.  
 The medical reserve corps—its duties and relations to the army in peace and war—US-43, March, 13.  
 Naval doctors—Ar-1, January, February, 13.  
 Proposed law as to maneuvers of troops on private property—US-37, May-June, 13.  
 A proposed method of pitching and striking a field hospital rapidly—US-43, April, 13.  
 Reorganization of the sanitary service of the Brazilian army—Br-1, March, 13.  
 Sanitary service—Po-4, November-December, 12.  
 Service of medical officers in the field—M-2, February-March, 13.  
 Transport and supply, and their relation to the medical service in the field—UK-4, April 8, 22, 13.  
 Transportation of wounded on the field of battle—Sp-3, February 25, 13.

## METALLURGY

- Commercial production of sound steel ingots—US-9, April, 13.  
 Determination of nickel in special steels—I-4, February, 13.  
 Manufacture and treatment of steel for guns—US-38, March-April, 13.  
 The methods of testing metals at the congress in New York—F-10, Jan., 13.  
 Notes on early wire-drawing practice—UK-9, April 18, 13.  
 Plant for Hadfield method of producing sound steel ingots—US-9, April, 13.  
 Practical heat treatment of admiralty gun metal—UK-17, March 28, 13;  
 UK-9, April 18, 13.  
 The production of solid steel ingots—US-9, April, 13.  
 The protection of steel from corrosion—US-24, May, 13.  
 The rusting of iron—UK-9, April 18, 13.  
 The use of anti-piping thermit in casting steel ingots—US-9, April, 13.

## MILITIA

- Rapid field training of a National Guard regiment—US-30, May-June, 13.  
 Some suggestions on National Guard recruiting—US-46, December, 12.  
 The term "militia"—US-30, May-June, 13.  
 The territorial force. Some suggestions as to how to ensure attendance at drills—UK-3, April, 13.  
 The training of the national guard—US-30, March-April, 13.  
 Why states should have aviation corps—US-28, March, 13.

## NAVAL CONSTRUCTION, GENERAL (SEE ALSO WARSHIPS)

- Compressed air as a protection for battleships—US-65, March 22, 13.  
 Floating docks—Br-3, January, 13.  
 Foreign dreadnought developments—US-65, April 26, 13.  
 Frahm anti-rolling tanks—UK-8, March 14, 13.  
 The influence of air-pumps on the military efficiency of turbine-driven warships—UK-9, March 14, 13.  
 Institution of Naval Architects. (Mechanical gearing for the propulsion of ships)—UK-8, March 14, 13.

## ORGANIZATION, AT LARGE (SEE ALSO ARMIES AND NAVIES BY COUNTRY)

### *Army:*

The exercise of command—F-4, March 1, 13.

Four *versus* eight companies—UK-14, January, 13.

The organization of the European cavalry on the Bengal establishment from 1760 to 1772—UK-14, January, 13.

Questions on organization (enlistment period—selection and instruction of the personnel)—Ar-2, December, 12.

Reorganization of our national forces and providing officers of reserves—Be-1, January 12, 13.

The “three unit” formation—Co-1, September, 12.

Specialization for *l'artillerie a pied* (which includes, siege, dismounted field, land-fort, and coast batteries)—F-2, January 28, February 21, 26, 13.

## PHILOSOPHY AND PSYCHOLOGY

As the officers, so the troops—Ar-1.5, September, 12.

A plea for comradeship in the Indian army—UK-14, January, 13.

Psychology and the navy. (An abstract of an article by Hugo Munsterberg in the February, 1913, *North American Review*)—US-6, February 1, 13.

Psychology of the commander in chief—Br-1, December, 12.

War and the survival of the fittest. III—US-66L, January 18, 13.

## PHOTOGRAPHY

Equipment for district photography—US-60, March-April, 13.

## PHYSICS (ESPECIALLY MECHANICS, HEAT, AND SOUND)

Photographing sound. A fine demonstration of wave motion—US-66L, February 15, 13.

Standardization of the Myriawatt—UK-17, February 28, 13.

## POLITICS AND POLICY

India and imperial defense—UK-26, February, 13.

The military policy and institutions of the British Empire—UK-26, March, 13.

Obligatory military education in Japan—Sp-1, January, 13.

Obstacles to obligatory military service, and how to overcome them—M-2, January, 13.

Policy. (Lecture before Army War College on relation between war and policy.)—US-30, January-February, 13; US-47, March, 13.

Russia's naval policy—US-47, March, 13.

## PRACTICAL TRAINING

### *Coast Artillery:*

Preliminary course for observers for coast artillery—Po-2, October, 12.

### *Mobile Army:*

Practice camps, 1912, and the lessons to be learnt from them—UK-11, February, 13.

Progressive infantry instruction—US-30, January-February, 13.

## PROJECTILES

Penetration and destructive qualities of artillery projectiles—Co-1, November, 12.



### RADIO-TELEGRAPHY AND RADIO-TELEPHONY

The approaching changes in wireless practice—US-38, January-February, 13.

Long distance wireless telegraph stations of the U. S. Government—UK-6, February 7, 13.

The radio conferences of London and Paris—I-4, December, 12.

Wireless telegraphy in Spain—Po-3, October, November, December, 12.

### RECONNAISSANCE AND SKETCHING

An incident without precedent. (Aerial reconnaissance in the Italian-Turkish war)—R-2, November, 12.

### RESERVES

How may service with the colors be combined with a period of service as a reservist so as to create a dependable reserve for the first line—US-37, March-April, 13.

Militia of one year and providing officers of reserves—Be-1, December 22, 12, January 26, February 2, 13.

The national reserve—UK-13, January, 13.

The necessity for a military reserve—US-30, January-February, 13.

Territorial infantry—UK-26, February, 13.

### SCHOOLS

Instruction of regimental officers—Co-1, November, 12.

Obligatory military education in Japan—Sp-1, January, 13.

Observations on the instruction of Columbian officers—Co-1, September, 12.

Organization of the naval schools of Germany and Austria—UK-13, January, 13.

The War College and the course of military engineering—Po-3, July, August, September, 12.

### SEARCHLIGHTS

Modern projectors for armies—I-3, November, 12.

### SIEGE ARTILLERY

Some thoughts on fortress warfare—UK-11, January, 13.

### SIEGE OPERATIONS

History of siege warfare—F-12, January, 13.

Some ideas on siege warfare—I-3, November, 12.

### SMALL ARMS

The explosive action of rifle bullets—I-3, October, 12.

The infantry rifle and the machine gun: their use on the battlefield—F-4, January 15, 13.

The rifle of the future—UK-11, February, 13.

The "Scheele" system of aiming control—Ar-1.5, September, 12.

Something about the development of the pneumatic gun—US-5, February 13,

13.

of the bayonet—UK-14, January, 13.

## STRATEGY AND TACTICS

*Cavalry:*

Tactical problems for the cavalry to solve—Br-1, January, 13.

Use of cavalry—Ar-1.5, October, November, 12.

*Field Artillery:*

Artillery in an infantry attack—Ar-1.5, September, October, November, 12.

Cooperation between infantry and artillery—Ar-1.5, October, November, 12.

The employment of artillery in the Russo-Japanese war from the beginning to the strategical deployment—I-3, November, 12.

*General:*

Changes in battle tactics—Co-1, November, 12.

Cooperation between infantry and artillery—Ar-1.5, September, 12.

The dawn of modern tactics—UK-26, February, 13.

The decisive attack—US-30, January-February, 13.

The influence of new tactical methods on military operations—I-3, October, 12.

Ireland and national defense—UK-13, January, 13.

The latest information from Saumur on the subject of tactics—M-2, Jan., 13.

Natural *Points d'Appui*—UK-21, February, 13.

Training and action necessary to further cooperation between artillery and infantry—UK-13, January, 13.

Stray ideas on topical strategy—UK-26, February, 13.

*Infantry:*

Cooperation between infantry and artillery—Ar-1.5, October, November, 12.

A study of the tactical employment of the rifle and the machine gun—F-4, February 1, 15, March 1, 13.

*Naval:*

Evolution of recent types of men-of-war and their tactical employment—F-14, October, 12.

## SUBMARINE VESSELS

The battleship and the destroyer—UK-8, February 14, 13.

The evolution of the submarine—US-17, February, 13.

Guns for submarines. A weapon that swings below deck during submergence—US-65, March 8, 13.

Krupp guns for submarines—F-3, March 1, 13.

## TARGETS AND TARGET PRACTICE

*Coast Artillery:*

The development of coast artillery target practice—US-38, Jan.-Feb., 13.

How may the best results at coast artillery target practice be secured,—including preliminary instruction, training, preparation for, and conduct of, practice,—for guns of 8-inch to 12-inch caliber—US-38, Jan.-Feb., 13.

Some ideas on the subject of fire control—UK-11, February, 13.

*Small Arms:*

Discussion in favor of the adoption of electrical target of the Bremer type—Br-2, October, 12.

Japanese small arms firing regulations—F-13, January 15, February 15, 13.

Target practice—US-5, February 27, 13.

Two inventions for landscape targets—UK-14, January, 13.

When the new firing regulations will come—US-5, January 30, 13.

The reorganization of our national forces and providing officers of reserves—  
Be-1, May 4, 13.  
Our reserve system—US-30, March-April, 13.

#### SCHOOLS

The Army Service Schools—US-27, January-March, 13.  
The Army Signal School—US-30, May-June, 13.  
The Belgium cavalry school at Ypres—Be-1, April 13, 27, 13.  
Competitive entrance examination to the staff college in 1913 (tactical problem)—F-4, March 15, 13.  
The military education of youth—C-1, April, 13.  
Military schools for recruits—Sp-3, January 25, 13.  
Naval school for Portugal—Po-1, January, 13.  
On the military historical study of officers—G-5, No. 13, 12.  
Portuguese war college—Po-4, November-December, 12.  
Post-graduate department, Naval Academy—US-7, March 29, April 5, 13.  
The school of gunnery, Shoeburyness—UK-3, April, 13.  
The school for military gymnastics at Joinville-Le-Pont—Po-4, January, 13.  
Separation of the schools for artillery and engineers, in France—Sp-3, February 10, 13.  
The training of regimental officers of detached units—UK-5, January, 13.  
Two early proposals for naval education—US-59, March, 13.

#### SEARCHLIGHTS

Application and use of the searchlight—Sd-4, No. 1, 13.  
Projectors on warships—I-4, February, 13.

#### SIEGE ARTILLERY

Fortress artillery and the service of production and conservation of matériel in the principal armies—I-3, December, 12.  
Siege guns in the fall maneuvers of the French army—G-5, December 31, 12.

#### SIEGE OPERATIONS

Defense of fortified places—C-1, April, 13.  
History of siege warfare—F-12, February, March, 13.  
Siege warfare—UK-21, May, 13.

#### SIGHTS

Adjustment of telescopic sights—Po-4, November-December, 12.

#### SIGNALLING, VISUAL

The development of optical telegraphy for military purpose from the beginning to the present time—G-8, January, 13.  
Transmission of orders during the naval battles of the Russo-Japanese war—US-59, March, 13; C-2, Jan., 13.

#### SMALL ARMS

The Brixia automatic pistol—Be-2, January-February, 13.  
The cartridge (small arms) of the future—Sp-3, April 10, 13.  
An extemporized hand grenade—UK-21, April, 13.  
The form and use of the saber—US-30, March, 13.  
Machine guns and automatic rifles—Ar-2, March, 13.

Maxim silencer—favorable report on its use in Mexico—Sp-3, January 25, 13.

The Remington “negative angle” sighting system—US-41, April, 13.

Rifle sights—UK-5, January, 13.

Semi-automatic musket tests—US-7, May 3, 13.

Suggestion for pistol practice—US-30, March-April, 13.

System in bayonet fencing—US-30, March-April, 13.

#### STRATEGY AND TACTICS

##### *Cavalry:*

Advance guard problem for a troop of cavalry—Ar-2, January, 13.

Cavalry in the Russo-Japanese war—Be-2, January-February, 13.

Employment of cavalry in retreat—UK-3, April, 13.

The Fredericken cavalry at work—Be-1, April 13, 13.

Tactical notes from Saumur—M-2, February, March, 13.

##### *Field Artillery:*

Attack by detail, of field artillery—Ar-2, March, 13.

The disposition of artillery in action—Au-3, No. 1, 13.

Employment of artillery in advanced positions—Pe-1, January 31, 13.

Employment of field artillery in combat according to English instructions—  
I-3, February, 13.

Heavy and field artillery in Russian-Japanese war. Experiences and reflections—N-1, No. 6, 11.

The instruction of artillery for the land defense of Lisbon—Po-2, Dec., 12.

Masked fire of the artillery—US-27, January-March, 13.

Principles of employment of artillery in the field—Pe-1, March 15, 13.

A Russian view of supporting the decisive infantry attack with artillery—  
US-27, January-March, 13.

The use of cover—Po-2, November, 12.

Use of field artillery—Po-2, January, 13.

##### *General:*

The close relation of the proper leading of infantry and field artillery on the battlefield—II-1, February 21, 13.

The combined training of infantry and artillery—UK-2, March 15, 13.

An early treatise on tactics—US-5, May 8, 13.

The evolution of war—Co-1, January, 13.

Fortress defense. Conventions opposed to the offensive spirit—UK-21, April, 13.

Freedom of maneuvers—UK-3, April, 13.

German opinions of modern warfare—US-37, May-June, 13.

German strategy and tactics (propos the Balkan war)—Co-1, January, 13.

Military maxims—Sp-3, April 25, 13.

Military theory, practice and experiment—UK-11, April, 13.

Modern war (German vs French schools)—Co-1, January, 13.

Night marching during the Boer war—D-1, November 15, 11.

Problems for the tactical instruction of troops—C-1, February, 13.

Relative merits of French and German tactics in the Balkan war—Co-1, March, 13.

A strategic anomaly (a study of the tactics of the war in the Balkans)—  
UK-11, March, 13.

The strategy of Frederick the Great during the Seven Years War—G-5, No. 2, 13.

*Infantry:*

Leading infantry against cavalry—Ar-2, March, 13.

*Naval:*

Comparative study of the evolution of the tactics of sailing and steam vessels—Sp-4, February, 13, March 13, 13.

The defense of bases of naval operations—C-2, February, 13.

The influence of coast fortresses on naval strategy—US-38, March-April, 13.

Maritime strategy in the works of Corbett and Mahan—I-4, March, 13.

Naval power. (Translation of article by Admiral Fiske, U. S. N.)—C-2, January, February, 13.

Naval warfare (conclusion)—C-2, January, 13.

Naval strategy in its relation to military strategy—F-14, Jan., Feb., 13.

Notes on the applicatory system of solving war problems, with examples, etc. (Translation of article appearing in *Proceedings of U. S. Naval Institute*, Sept., 1912)—F-14, December, 12.

A strategic value of the Panama Canal to the navy—US-47, May, 13.

Weapons and tactics—UK-2, March 15, 13.

## SUBMARINE VESSELS

The development of protection against submarines—Po-1, September, 12.

The (French) submarine *Mariotte*—F-16, April 19, 13.

Irregularities of motors on submarines—F-16, April 19, 13.

The Krupp guns for submarines—G-1, January, 13; UK-9, March 7, 13.

Modern submarines—Ar-1, January, February, 13.

Panoramic periscope for submarines—(Goerz type)—Po-1, September, 12.

Resistance and speed of submarines—UK-8, April 11, 13.

Sound signals for submarine vessels—F-16, May 3, 13.

The submarine *Espadarte*—Po-1, September, 12.

Submarines in the United States navy—F-16, April 5, 13.

Submarines and their application. (A detailed article)—Au-3, No. 12, 12.

System for rescue and safety on the submarine *Espadarte*—Po-1, November-December, 12.

## SUPPLY DEPARTMENTS (SEE ALSO LOGISTICS)

A new field oven for continuous production—I-3, Dec., 12.

## TARGETS AND TARGET PRACTICE

*Field Artillery:*

Orders relative to artillery practice in the French army for 1913—F-2, January 3, 13.

Sub-caliber practice—US-27, January-March, 13.

*Naval:*

Target practice instruction in the Portuguese navy—Po-1, Nov.-Dec., 12.

Sub-caliber drill—US-59, March, 13.

*Small Arms:*

The Ellis self-marking target—Ar-1, January, February, 13.

The German firing regulations for the infantry—Sd-3, No. 1, 13.

Japanese small arms firing regulations—F-13, March 15, 13.

Life targets (bioscope)—UK-7, April 4, 13.

Rifle competition in France—Ar-2, March, 13.

### TECHNICAL TROOPS (ENGINEERS, SIGNAL, ETC.)

- Engineers of the expeditionary force—UK-3, April, 13.  
 Notes on the origin of the engineer arm—I-3, January, 13.  
 The pioneers of the German army—UK-3, April, 13.  
 Practical notes for foremen and superintendents of engineering construction—M-1, January 16, 13.  
 The work of a divisional signal company in battle—UK-3, April, 13.  
 Work of the French engineer corps in Algeria-Morocco during 1911—I-3, December, 12.

### TELEGRAPHY

- General study of the telegraph and telephone, and their use in the field—M-1, January 16, 13.

### TELEPHONY

- General study of the telegraph and telephone, and their use in the field—M-1, January 16, 13.  
 Telephones for infantry (field telephones)—Pe-1, February 28, 13.

### TELESCOPES, GLASSES, AND TELESCOPIC INSTRUMENTS

- The infantry binocular—Sp-3, February 10, 13.

### TORPEDOBOATS AND DESTROYERS

- Destroyer developments—UK-8, March 14, 13.

### TORPEDOES

- Air heating modifications in the Whitehead torpedo—Br-3, February, 13.  
 The Davis gun torpedo—Po-1, November-December, 12.  
 On the long range launching of torpedoes—F-14, December, 12.  
 The turbine gyroscope (Whitehead torpedo)—Br-3, January, 13.  
 The torpedo firing problem—UK-13, March, 13.

### UNIFORM CLOTHING

- The uniform for infantry—Be-1, May 4, 13.

### WARSHIPS, BY COUNTRY

#### *Brazil:*

- The Brazilian battleship *Rio de Janeiro*—Br-3, February, 13; F-3, March 15, 13; Au-1, No. 3, 13.

- Launching of the torpedoboat destroyer *Douro*—Po-1, January, 13.

- The training ship *Benjamin Constant*—Br-3, January, 13.

#### *France:*

- The naval mine planters *Pluton* and *Cerbère*—F-3, April 26, 13.

#### *Germany:*

- The German battleships of the *Kaiser* class—UK-8, April 18, 13.

#### *Italy:*

- The first triple-turreted warship. A new Italian battleship marks a departure from existing types—US-65, May 10, 13.

#### *United Kingdom of Great Britain and Ireland, Its Colonies and Possessions:*

- The English battleship *King George V*—US-38, March-April, 13.

*Other Countries:*

The Chinese training cruiser *Chao Ho*—UK-9, March 28, 13.

MISCELLANEOUS

Can our system of recruiting be improved—US-30, May-June, 13.

The fund for widows and orphans of officers—Be-1, April 20, 27, 13.

Government and the sea. (What the U. S. government has done to protect lives and property at sea)—C-2, February, 13.

The introduction of military service in Dutch East India (continued)—H-1, November 22, 12, January 10, 13.

Influence of wind on height of tide—Ar-1, January, February, 13.

Moving pictures for recruiting—US-30, May-June, 13.

On recruiting—US-37, May-June, 13.

Our military decline—US-30, March-April, 13.

Our unpreparedness for war—US-30, March-April, 13.

Recruitment by moving pictures—US-30, May-June, 13.

Revolutionary army orders. For the main army under Washington 1778-1779—US-76L, April, 13.

The "Spanish Explorers" (boy-scout organization)—Sp-3, February 10, 13.

A suggestion as to selection—US-37, May-June, 13.









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IS ARTILLERY

*er pour les ignorans  
es habiles gens."*

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NE, 1913

WHOLE No. 121

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TYPE OF PROJECTILE  
ING ARMAMENT OF  
EACOST FORTIFICA-

ONS

CAPTAIN PAUL D. BUNKER, COAST ARTILLERY CORPS

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There is very little literature extent relating to the design of projectiles. Perhaps this is because the subject is dependent primarily upon the "cut and try" method, pure theory playing a minor part. Some few experts may have gradually accumulated a great store of empirical data on the subject, but little, except generalities, is known to the average person. The said experts can hardly be expected to enlighten us, as their information is the source of their livelihood and their firms' reputations.

In the following discussion no attempt will be made to assume the position of one of these experts, and no mention will be made of such technical points as the rate of decrease of metal in successive cross-sections, the exact composition of the various alloys of steel used, or methods of manufacture. This paper will refer simply to the projectiles now in use in our service, and express the writer's opinions upon their suitability for the purpose and how they might be improved.

For the sake of brevity, in order to avoid the necessity of discussing separately the various kinds of projectiles for each caliber of gun in our service, let us select certain calibers that will represent the whole fixed armament of our coast defenses, leaving out of consideration their mobile armament. This is but logical, because the proper design of a projectile is practically dependent upon the kind of work required of it—the nature of its target, in other words—and that depends upon the caliber of the projectile in question.

The typical guns of the different classes are as follows:

Primary: 12-inch or larger guns, 12-inch mortars.

Intermediate: 6-inch guns.

Secondary: 3-inch guns. (Par. 10, C. A. D. R.)

Now, considering the proper targets of the above named cannon, and also the necessity for target practice, we may classify all of our projectiles according to their use or purpose, as follows:

- A. For use in target practice—
  - 1. Sub-caliber practice,
  - 2. Service practice.
- B. For use in war against—
  - 1. Unarmored craft, small boats, landing parties,
  - 2. Light armored craft,
  - 3. Heavy armor, turrets, etc.,
  - 4. Deck armor.

The following discussion will follow the general divisions shown above, except in such matters as are general in their nature and pertain more or less to all of our projectiles. These general characteristics will be discussed first, taking up in order the various details of a typical projectile, and endeavoring to find ways in which they might be changed to advantage. We shall then take up the synopsis shown above and state the writer's opinion as to the proper combination of these improved details to produce the best projectile in each case.

## I.

### GENERAL CHARACTERISTICS OF PROJECTILES

#### 1. THE HEAD

Most of our projectiles, except those for mortars, have an ogival head struck with a radius of 2.02 calibers. Many shapes of head have been tried, but it is found that the ogive, while

giving sufficient metal at the point, opposes least resistance to the air. However, in any ordinary projectile it will be found that the principal retarding influence is not the head resistance or the skin friction, but the eddy currents formed about the flat base of the projectile. If any method could be found of preventing this "drag," then the minimizing of the head resistance would assume fresh importance.

The radius of the ogive is dependent upon two conflicting desiderata, ease of flight through the air and strength of point. The latter item is paramount in armor piercing projectiles only. Hence it would seem allowable to supply our 3-inch shell with a sharp point, not for increasing penetration, but for reducing air resistance. It is believed that in such a case an ogival radius of at least five calibers might be adopted without ill effect. This would give an appreciable increase in range, over that formerly obtained.

In the case of armor piercing projectiles, the situation is somewhat different, as the strength of the point must be preserved at any cost. This refers especially to the extreme point and a few inches back of it, for, according to Tressider, it is ordinarily the breaking down of the extreme tip which starts the destruction of the projectile. The latest practice seems to be in favor of slightly snubbing the point, in order to strengthen it. The Firth rendable shot designed for the Ordnance Department is an exemplification of this practice which, among other advantages, permits and even renders desirable a greater ogival radius in order to avoid a point that is too blunt.

With armor piercing projectiles we can take care of the head resistance by proper designing of the cap. Data relative to the difference in air resistance due to blunt or sharp caps are scarce. However, it will be admitted that our old form of cap must have caused an appreciable increase of this resistance over that caused by some of the forms of caps used abroad. The Johnson cap caused a greater resistance than would be experienced by an uncapped projectile, whereas most foreign caps, being sharper than the projectile itself, showed the opposite effect. It is claimed by ordnance experts that the blunt form is the better, in so far as purely armor piercing work is concerned, and proof firings substantiate this statement. But might not the use of a sharp cap, especially at the longer ranges, increase the striking velocity of the projectile to such an extent that the better (?) form of cap would more than lose its advantage? Also, we must remember the difference between

proof conditions, and those arising in actual war. At present, the best practice seems to be to use a blunt cap, on account of its superior armor piercing qualities, and to place in front of it a thin shell of metal in the shape of a hollow cone, to reduce the air resistance. Thus a long pointed cap may be composed of two or more pieces, so assembled as to leave two hollow spaces, or cells, one in the nose of the cap, and the other, an annular space, at the bottom of the cap. A certain Hadfield design has two such cells in the point of the cap, arranged in series.

The French coast artillery use a projectile termed the "P" shell, which is approximately as shown in Fig. 1. "Experiment has proved" that the form of head used with this projectile has important advantages, in that the projectile, after striking

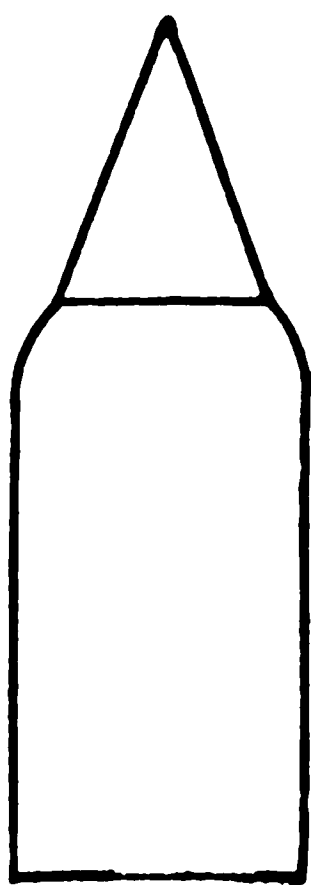


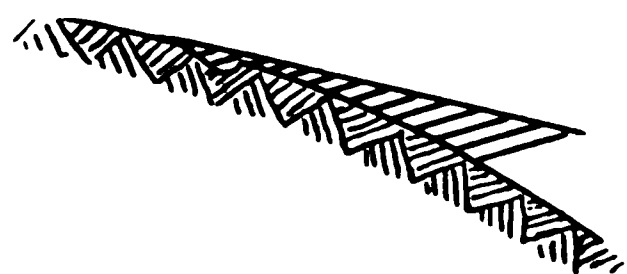
FIG. 1.

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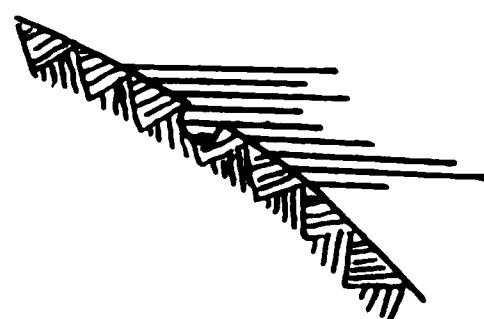
the water, has a tendency to continue along the direction of its trajectory, and is deviated therefrom much less than is the ogival headed projectile. It is known that a projectile striking water or sand, etc., will tend to work upward, above the continuation of the trajectory, and emerge, unless the velocity is lost. It is claimed for the "P" shell that this tendency is much less marked, and that this peculiarity is due to the shape of head, which is conical until it joins the ogive near the shoulder. So far as known, no experiments have been made to determine whether this effect would result from the use of a sharp pointed projectile, or whether it is restricted to those with conical points. This would be a great advantage in a projectile for coast artillery purposes, as it might convert a harm-

less "short" into a dangerous attack upon the hull of a battleship below the armored belt. Experiment seems to show that a projectile may travel at least one hundred calibers horizontally under the water before entirely losing its velocity. This is a chance not lightly to be disregarded, and would seem to be an argument in favor of a sharp cap like the Krupp design.

An extreme form of cap has been designed which extends clear to the base of the projectile in a form of jacket. However, it is believed that the weight of metal allowed to the cap should be kept within rather strict limits. Our old cap represented about two per cent of the total weight of the projectile; while our new cap for the 12-inch B.L. rifle represents nearly six per cent, and the Hadfield cap represents over seven per cent. In fact, all of the sharp caps require considerably more metal than does the Johnson type.



*PROPOSED*



*OLD STYLE*

FIG. 2.

1256

Designers are very particular as to the exact outline they give their caps. If experiment should prove the worth of the conical cap, it would be much easier of manufacture than one with a curved exterior and would be more economical of weight.

The method of attaching the cap could probably be slightly improved. The rear face of the groove cut around the projectile might be sloped a little to the rear, to avoid forming an abutment for the cap. (See Fig. 2.) This would make the method of attachment tend to approach the "fish-hook" principle in use by the French, and, it is believed, would have less tendency to weaken the head of the projectile.

*Summary.*—For non-armor piercing projectiles, an ogival radius of at least five calibers. For A.P. projectiles, an ogival radius of about 2.5 calibers from the bourrelet to within about 0.2 of a caliber of the point. From here on, the radius should be reduced to 1 caliber or even less. The cap to be hollow pointed, long and sharp, as nearly conical as possible, and to

extend about half way up the ogive. Fig. 3 shows the general form of head for an A.P. projectile embodying the above ideas.

## 2. THE BOURRELET

The rear part of the ogival head is turned down to a cylindrical surface, whose diameter is about 0.01 inch less than the caliber. This constitutes the front bearing surface of the projectile during its movement through the bore and is called the "bourrelet". Just before firing, the lowest element of the bourrelet is in contact with the lands of the rifling. When the piece is fired, the element of contact is continually changing until the bourrelet emerges from the bore. This results in a battering effect on the lands, mandreling them down in a manner that has misled some investigators of erosion. A wide

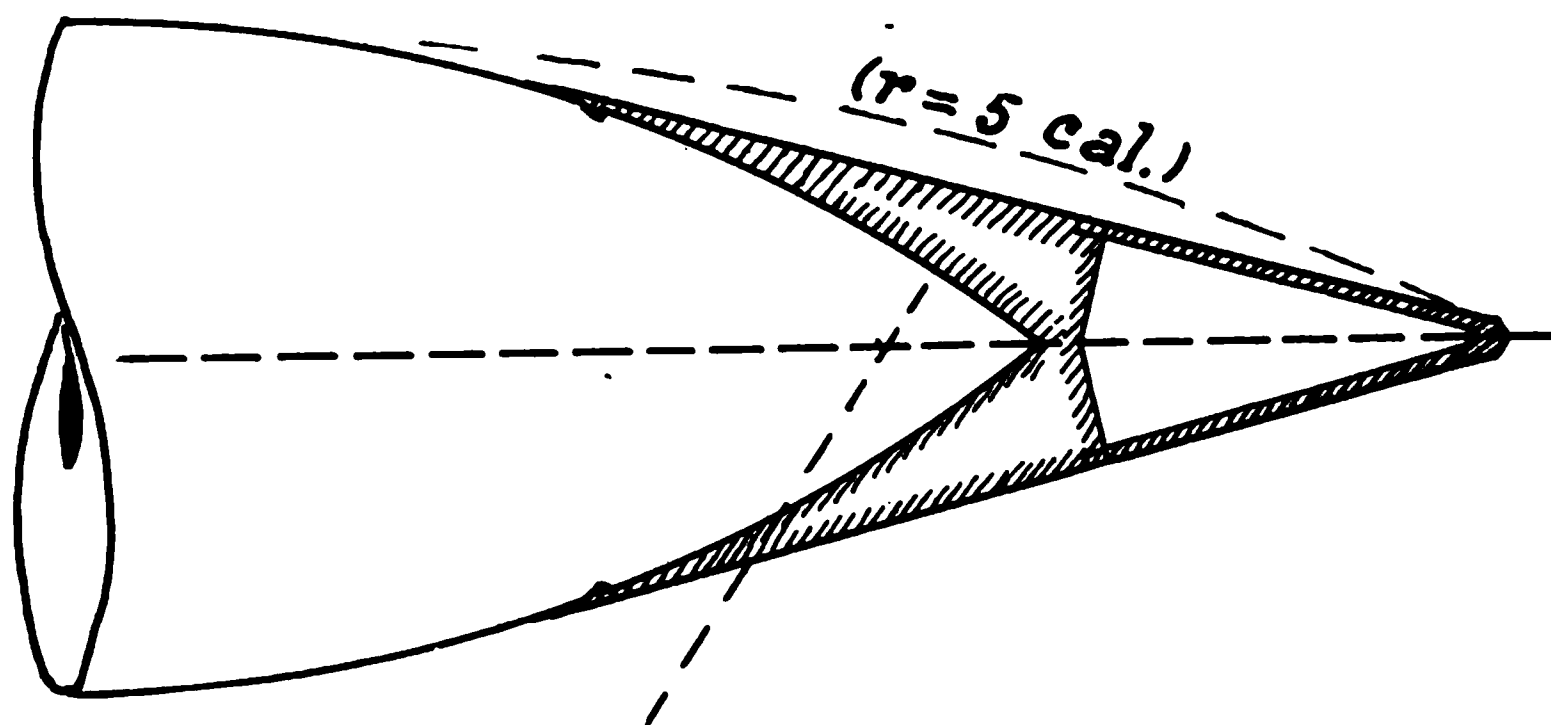


FIG. 3.

1257

bourrelet having a small clearance would cause less battering of the bore than would a narrow one having a larger clearance. The form and position of the rotating band also exercise a great effect on the amount of battering that a given projectile will produce. The width of bourrelet in most of our projectiles approximates 0.25 of the caliber. Using the slightly greater ogival radius advocated above would permit a corresponding widening of the bourrelet, resulting in a decreased battering of the bore.

## 3. THE BODY

The body of a projectile is the cylindrical part extending from the bourrelet to the rotating band. It is a few hundredths of an inch less in diameter than the bourrelet, for con-



venience in manufacture. The thickness of wall in the case of A.P. shells seems to follow closely the formula  $t = 0.19 d + 0.03$ , where  $t$  is the thickness of wall and  $d$  the caliber. This rule does not apply to our A.P. shot, where the thickness of wall continuously increases toward the point, starting with about 0.25 caliber just in front of the base plug.

The dominant feature of design in the case of an A.P. shot is the distribution of metal so that impact with the target shall not upset the projectile. The metal must be so placed as to give the most efficient punch effect. The weight of the projectile is fixed, and the best designed projectile of this type is that which will pierce the greatest thickness of armor and still remain in proper condition for effective detonation. This condition must of necessity impose serious limitations upon the volume of the cavity for carrying the bursting charge. How serious this is, can be seen by comparing the volumes of cavities in the 1906 model of A.P. shot and shell for the 16-inch rifle, which are 946 and 2864 cubic inches respectively. Assuming that 1 pound of explosive occupies 19 cu. in., we see that the bursting charges would weigh about 50 and 151 lbs. respectively. This great difference is due to the fact that the shell is designed principally with the idea of withstanding the upsetting shock of discharge, while, as before stated, the shot is designed to withstand the far greater shock of impact. In the opinion of most practical artillerymen, this great difference should be abolished and a compromise projectile evolved. These advocates of the single projectile idea seem to be steadily increasing in numbers. They believe that, since we cannot actually count upon having more than a few minutes in which to destroy the target, there is no time to waste in changing from one type of projectile to another.

One of the most notable improvements of recent times, having for its object the strengthening of the shell body, is the "ribbed cavity" projectile brought out by the Bethlehem Steel Co. Fig. 4 plainly shows its peculiar construction. It can readily be seen that such a projectile, while perhaps more expensive to manufacture, would, for a given strength, permit of a larger cavity. There is less dead metal used, the "ribs" literally trussing the projectile. Proof firing shows excellent fragmentation. This method of construction applied to our present A.P. shot would result in a longer projectile containing an increased bursting charge. It might be worth while, in this connection, to test the value of spiral ribs;

that is, instead of running the ribs longitudinally, to give them a twist corresponding to the rifling. Experiment might show that this refinement would be worth the extra expense of manufacture.

#### 4. ROTATING BANDS

The rotating band is an annular ring cut from a copper tube, expanded by heat and shrunk into place near the base of the projectile in a groove, which is usually undercut. This groove is scored or knurled to prevent independent rotation of the band. The copper is forced into a tight fit by being run through a die, and is then turned to size and shape.

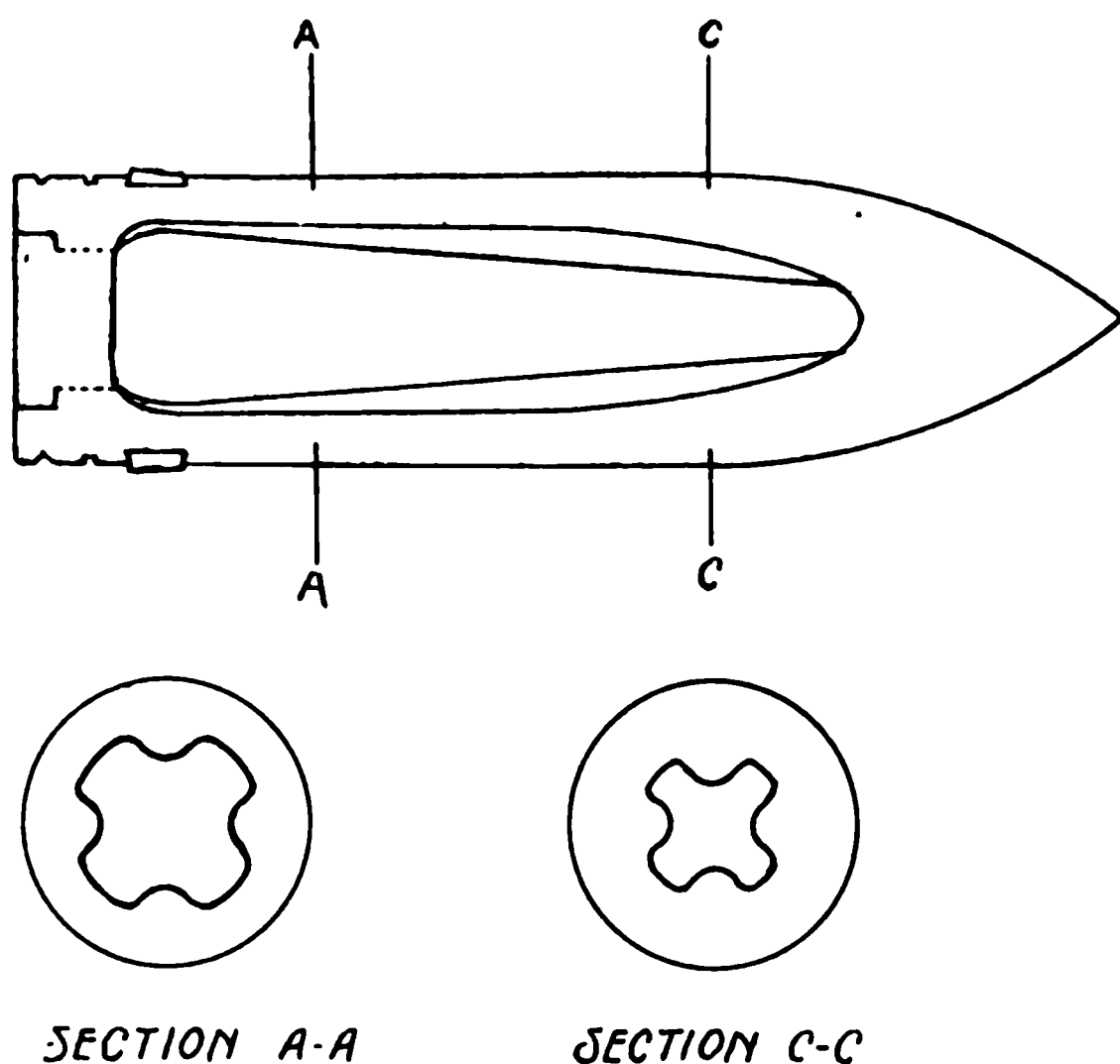


FIG. 4.

1258

The material used for bands has been the subject of countless experiments. The wide lead bands used many years ago by the French resulted in leading the bore. German silver and iron bands were tried but caused too much wear. Copper seems to be the survival of the fittest, although copper bands are sometimes stripped.

The exact position of the band is likewise of importance, as it has, among other things, an effect upon the range and accuracy of fire. Also, as the band groove is an unavoidable source of weakness, it should be placed where its weakening effect will be minimized, that is, well to the rear. A "closed-

in" base has a great effect in neutralizing the weakness resulting from the band groove. On fixed ammunition it must be placed far enough forward to permit the firm attachment of the cartridge case to the projectile. In the Bethlehem ribbed cavity 3-inch projectile shown in Fig. 4, the rear of the rotating band is 0.4 caliber from the base, but this would not do in the ordinary case. In our 12-inch projectiles this distance measures 0.17 caliber.

The contour of the band has received its share of attention. Fig. 5 is a representation of the band designed for the 12-inch A.P. shot, model 1896, showing the state of affairs at the instant of contact with the centering slope. (No drawings of bands of later model are at hand.) Theoretically, if the projectile were rammed about 0.4 inch further into the gun, thus deforming the "hump" at the rear of the band, the junk rings of the band would be in contact with the centering slope and

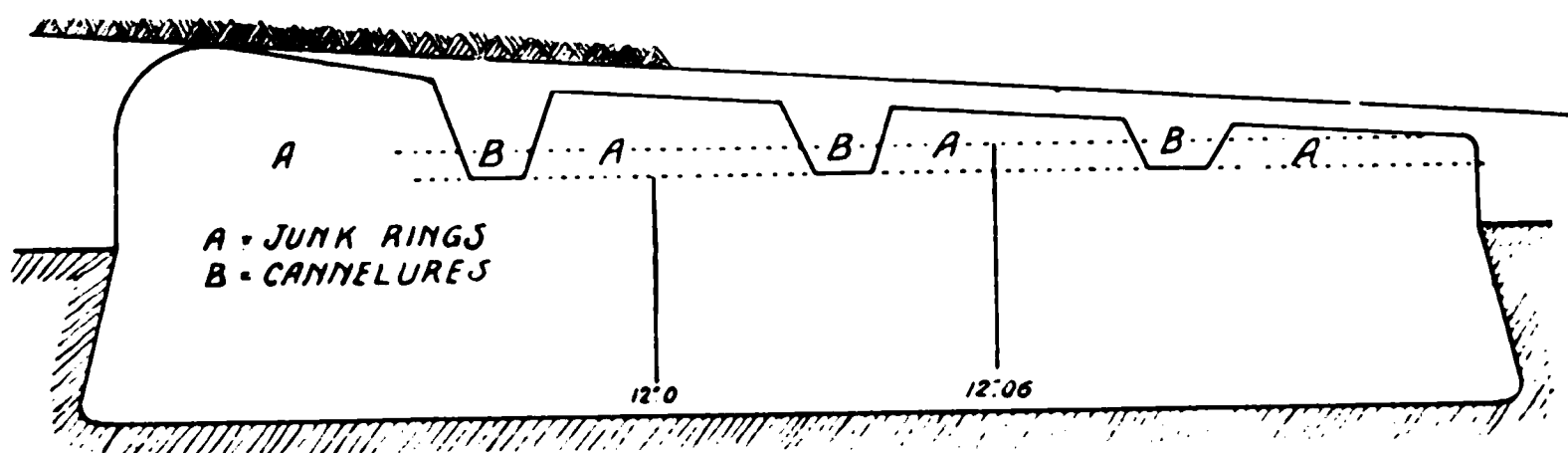


FIG. 5.

1259

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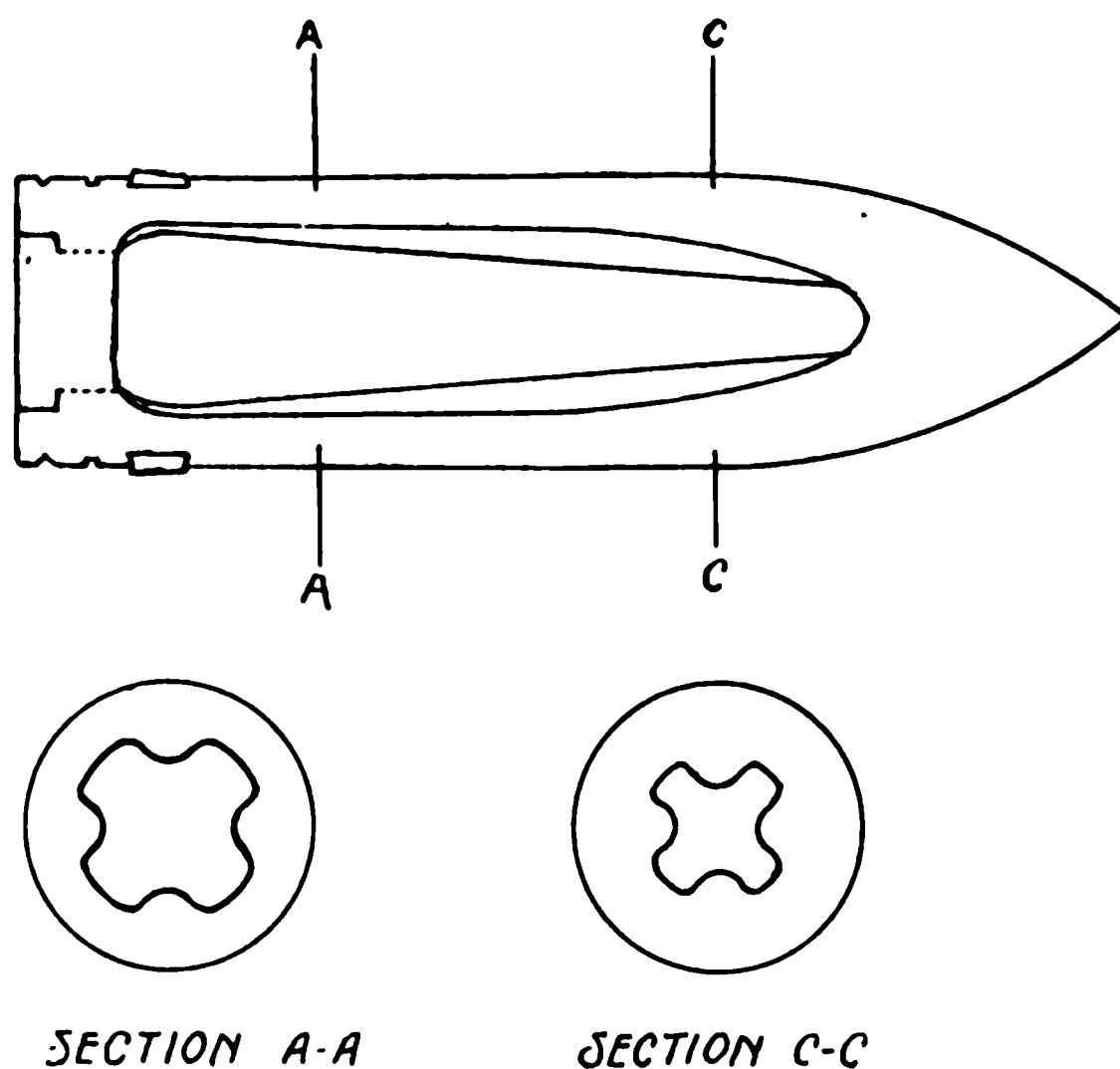


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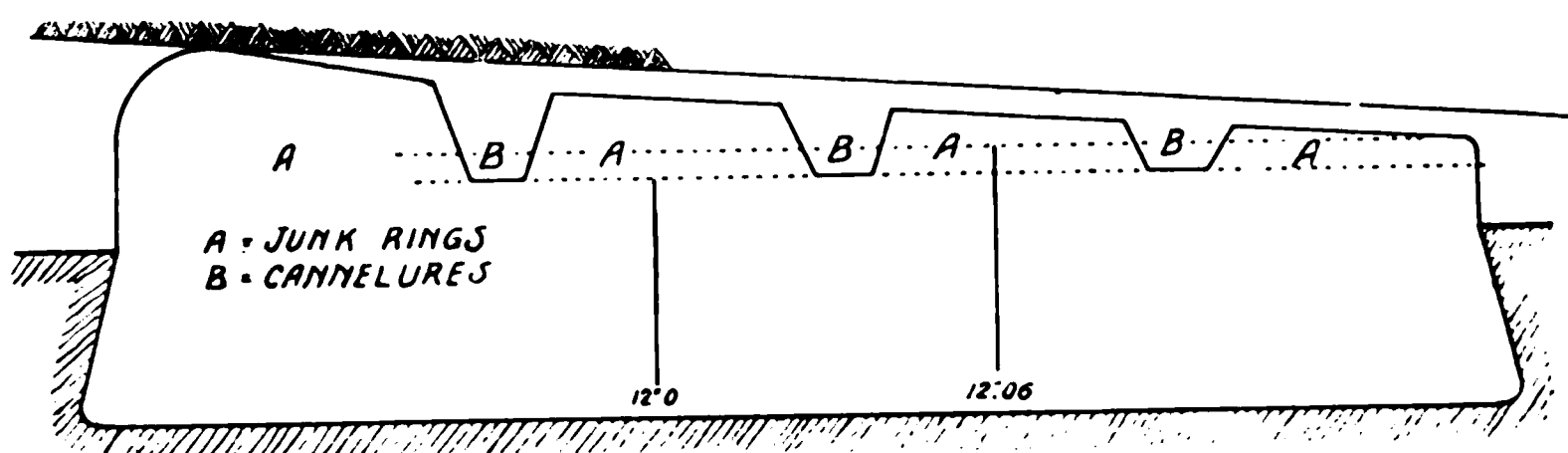


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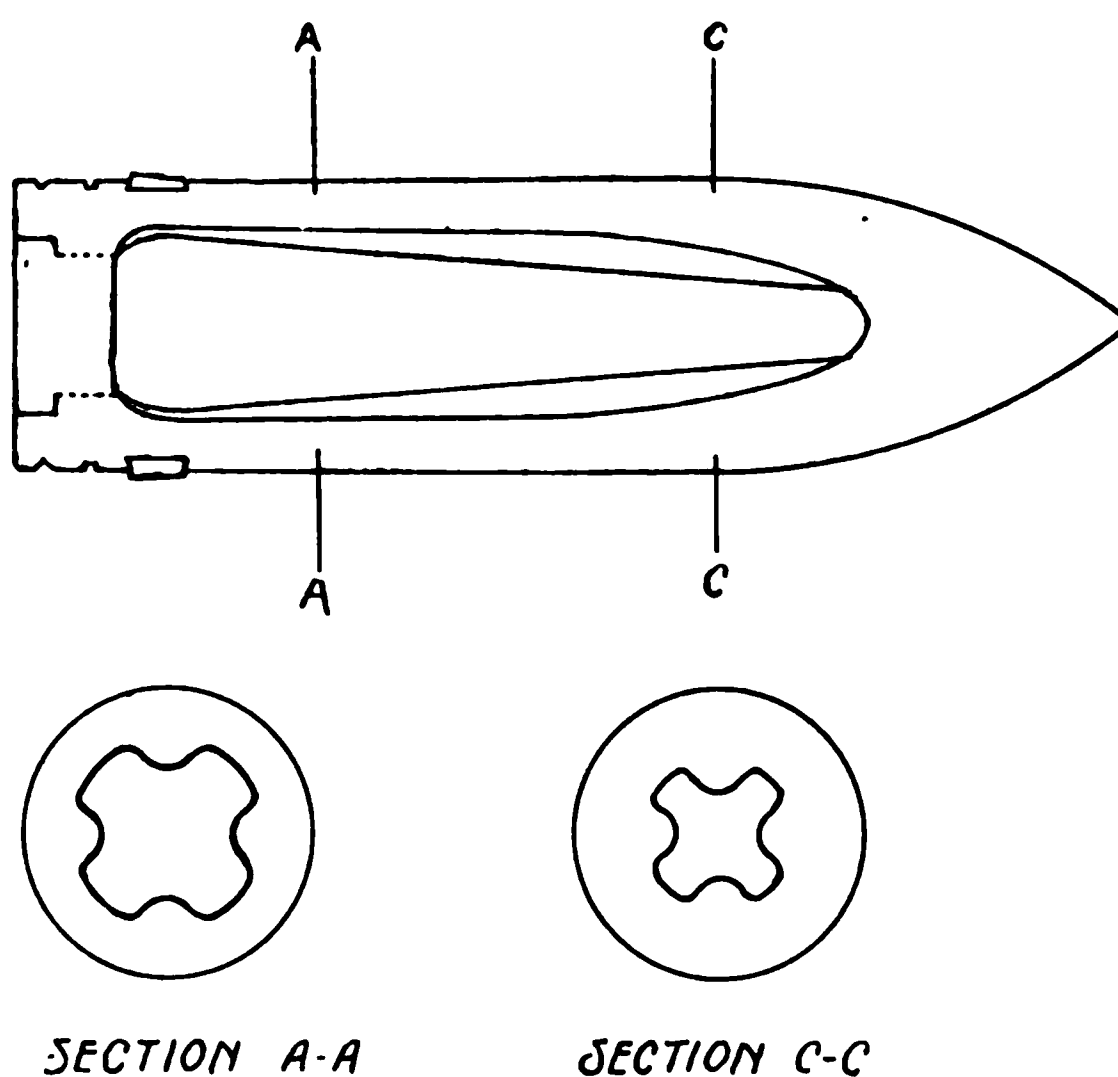


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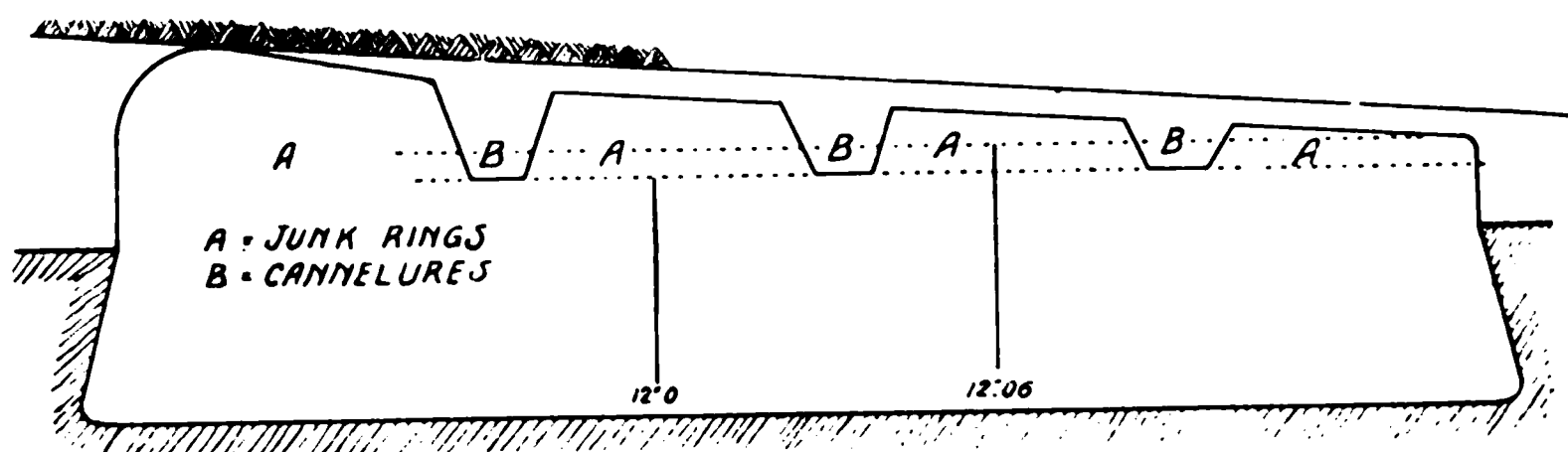


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excessive windage. Surely something can be done to improve the state of affairs shown in this picture.

As regards possible improvements in our bands, it is understood that a wide band has been adopted for use in our service, but its measurements are unknown to the writer. Now, the narrow bands seldom strip, and their width measures but 0.125 caliber. This narrow band causes comparatively little loss of energy in the bore. The wider the band we use the more energy of the powder do we lose in making it overcome friction and perform the necessary deformation of the band. Also, as our guns are rifled with an increasing twist, the junk rings are sheared circumferentially, thus adding to the loss of energy. Nobel deduced a value of over 4.7 per cent loss of energy when using a band 0.4 cal. wide and uniformly increasing twist ending with one turn in 35 calibers.

Another fact must be considered in connection with wide bands for our guns, and that is the steepness and brevity of our centering slopes. In the 12-inch B.L.R., model 1900, this slope is but 2.85 inches long, while our narrow band is 1.5 inches wide. Therefore we see that it is impracticable to increase the width of the band to any great extent without changing in some degree the design thereof. The wide band, needing a wide groove in the projectile, has the further disadvantage of increasing to a certain extent the weakening influence of this groove.

With all its disadvantages it is believed that the principle of the wide band is sound. There is little doubt that it decreases erosion, that it is better for use in guns already eroded and is less apt to strip. The writer is personally in favor of widening the bands (especially in the case of the larger calibers) to as near one third of the caliber as practicable. This need not increase the loss of energy in the bore to an alarming extent, provided we design the wide band so that the proportion of the areas of cross-section of the cannelures to that of the junk rings (*i.e.*, the copper sheared by the rifling) be considerably increased. The area of cross-section of the effective copper is approximately sufficient, even now, to prevent stripping; therefore there would be little advantage in doubling this area, if we decided to double the width of our band.

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Fig. 6.

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Fig. 6.

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narily made of the obturating function of these grooves. Now it will be found in the usual "dashpot" mechanism, that there are two or more annular grooves cut around the piston. These, usually in connection with the use of a suitable lubricant, greatly decrease the "windage" that would otherwise occur. Fig. 7 represents, as an example of this, the dash-pot used with the governor on the 25 kw. generating sets recently furnished the Coast Artillery. Another, and perhaps more apt example, is seen in connection with the "Broadwell ring" used with Krupp breech mechanisms. Thus it would seem reasonable

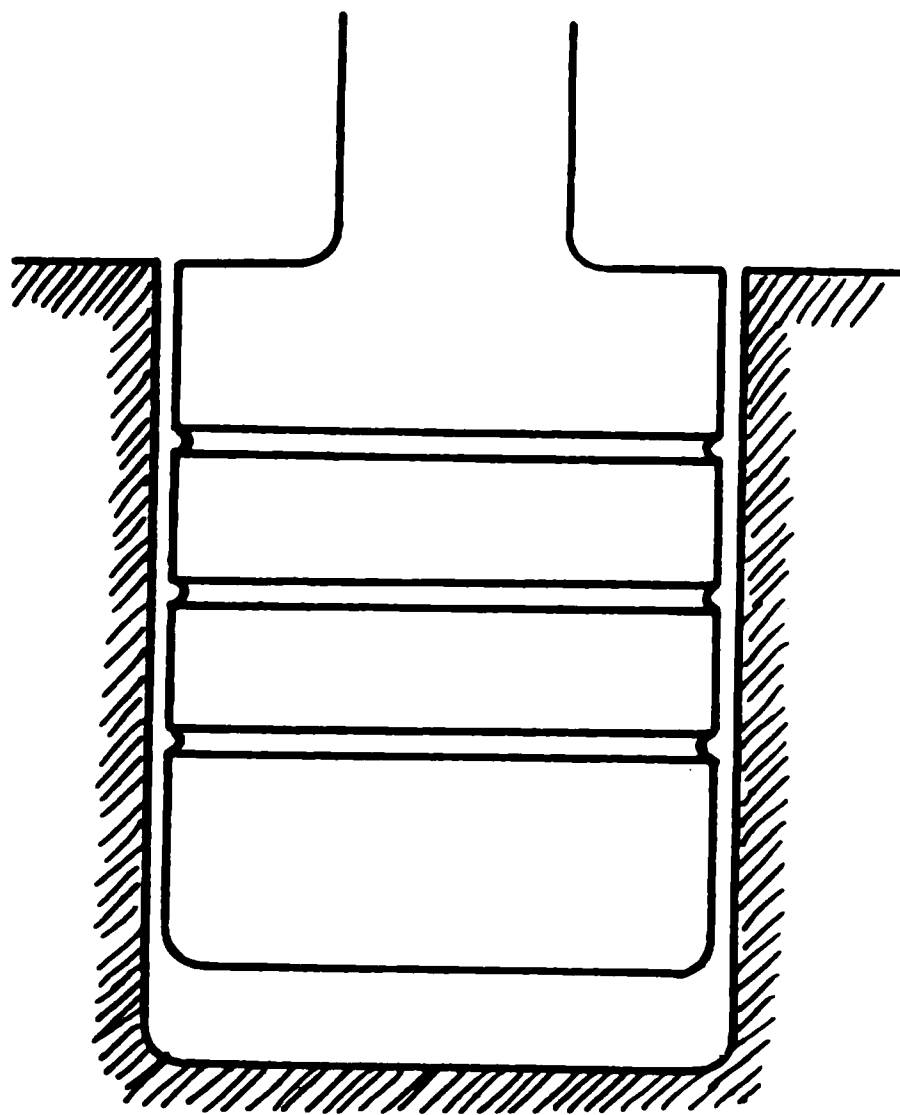


FIG. 7.

1260

to expect that an increase in the number of cannelures would decrease windage, with a corresponding effect upon erosion, and would also tend to decrease the energy lost in the bore. The practice of placing a lubricant in these cannelures has been in operation for some time in our Navy.

Another possibility in the line of band improvements is suggested by the old types of rotating band that were used with muzzle loading rifles. One of the best of these was invented by (then) Major Butler of the Ordnance Department. It is shown in Fig. 8. The gas pressure acted upon the groove and forced the lip into the rifling. It is not known to the writer whether or not any attempt has been made to utilize a



similar scheme in connection with our present type of bands. Presumably such attempts have been made, for the idea seems at least worthy of test. Our present bands, after the projectile has started, probably form approximations to such a device, due to deformation of the junk rings upon entering the forcing cone, but it would be better to have these "lips" formed upon ramming the projectile home, thus tending to seal the bore

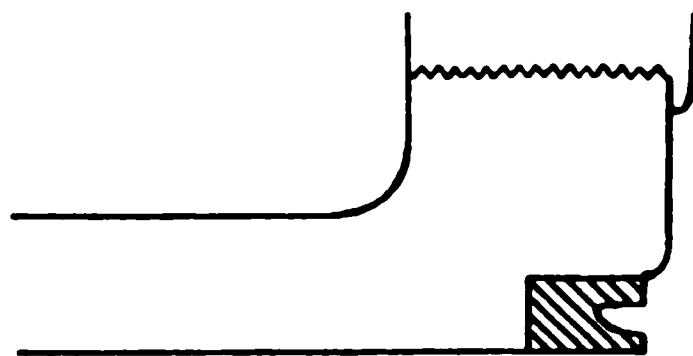


FIG. 8.

1261

more effectually and to prevent the first rush of gas seen in Fig. 6. Although no detailed drawings of the powder chamber, centering slope, etc., of the naval guns are at hand, it is probable that this is the purpose of the lip at the rear of the rotating band shown in Fig. 10b.

To recapitulate, the writer is in favor of a rotating band of the general shape and dimensions shown in Fig. 9. It will be noted that the increase in width is obtained by simply ex-

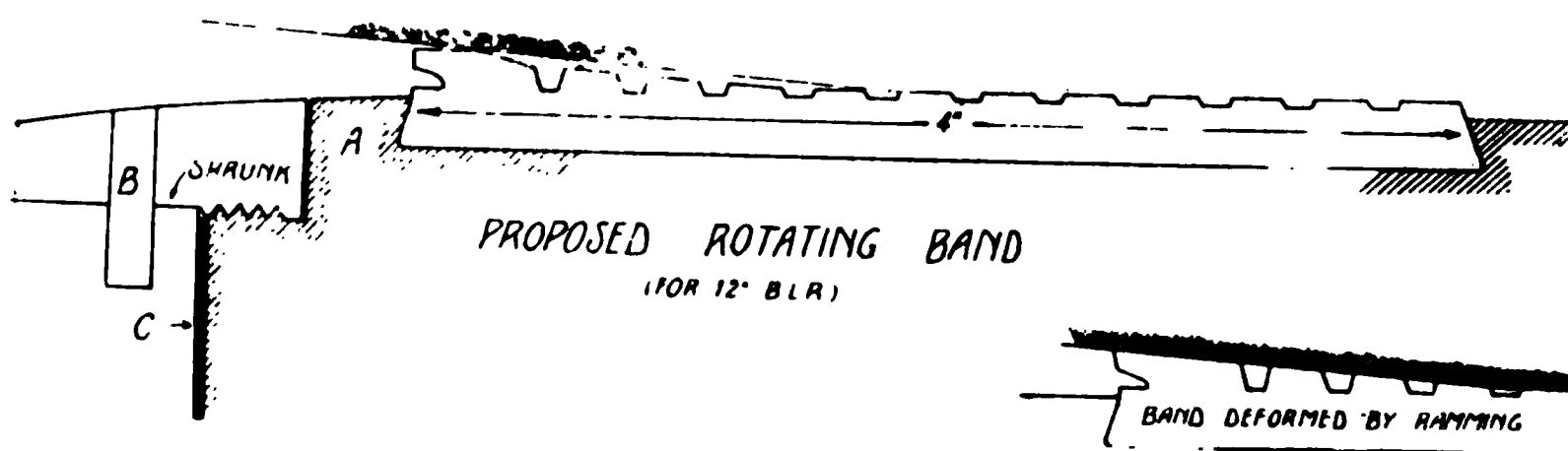


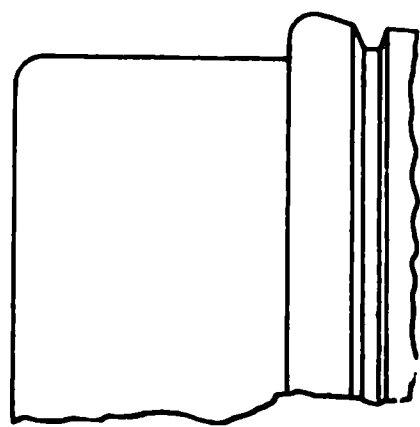
FIG. 9.

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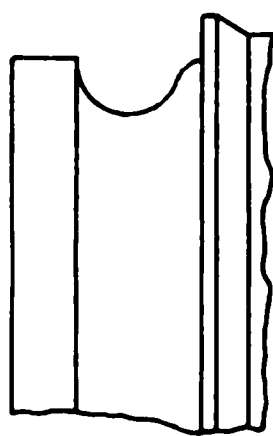
A, shearing ring; B, dowel; C, lead disc

tending the band forward with a diameter equal to that of the bore, measured across the grooves. This part of the band is cylindrical. A cylindrical surface can be turned accurately to dimensions much more easily than can a conical surface. Incidentally, it would be difficult, as before stated, to extend our present band much further to the rear on account of the characteristics of the centering cone. Now, as the lands are cut away at their beginning to form the forcing cone, there

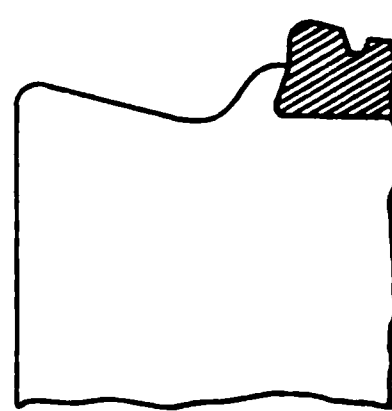
should be little if any difficulty experienced in ramming the projectile to a firm and proper seat, with about 2.5 inches of the band within the forcing cone and the last four junk rings in contact with the centering slope. It rarely happens that a ramming detail does not use force more than sufficient to overcome the slight resistance offered to the rifling by the extension to the band. As shown above, this part of the band with its seven cannelures being within the forcing cone cannot but greatly increase the obturating effect of the band, and it would also tend to prevent the projectile's being jammed back from its seat. In this proposed band there is considerably more effective copper than in the present band, but a greater proportion of the area of cross-section is allotted to the cannelures. Of the conical junk rings, all except the last are a trifle less in exterior diameter than in the present type, thus tending to



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FIG. 10.

minimize the deposit of copper along the bore. The position of the band as shown in Fig. 9 is to be considered as only tentative, depending upon experiment for its final position. It should be placed as far to the rear as may be found permissible, for reasons which will be discussed later. It is hoped that the adaptation of the Butler lip shown at the rear of the band might have some effect in decreasing windage, but test alone can settle the point.

### 5. THE BASE

Some of the various shapes given to the exterior surface of the projectile in rear of the rotating band are shown in Fig. 10. In actual firings against armor plate it was found that sometimes the pressure of the rotating band would cause the whole base of the projectile to tear off. Hence the adoption of a groove behind the rotating band, leaving just enough metal in

rear of the latter to withstand properly the stress imposed while in the bore. When the projectile pierces armor plate as far as the band, this small ring of metal is sheared off, leaving the rest of the projectile intact. This practice seems universally accepted as sound, and should therefore be applied to all of our armor piercing projectiles. In this connection it will be remembered that a statement was previously made to the effect that the shape of base of the projectile has a great effect upon the resulting atmospheric resistance to flight. The case is analogous to that of a yacht, where the designer must exercise care in arranging the ship's "entrance", and even more care in providing an afterbody that will leave the water with the least disturbance possible. In other words, "it's not the way she enters the water that counts, but the way she leaves it." The same principle applies even more strongly in the case of projectiles, on account of their comparatively high velocity. A little study of any of the exhaustive experiments available regarding atmospheric "stream lines" is very illuminating, some of them showing graphically the best forms of surfaces for minimizing the effects of air resistance. Of course, a projectile that tapered\* to a point in rear according to the proper law would be ideal, but such a shape has never been developed for artillery weapons. However, there seems to be no logical reason why we should not approach such an ideal as nearly as our circumstances permit. For instance, in Fig. 10, why should we not turn down the useless ring of metal that lies to the rear of the shearing groove in the rendable shot and the Navy A.P. shell? It is granted that this would tend to weaken the base of the projectile, but the use of a "closed-in" base (to be discussed later) would more than offset this weakening effect. Although the presence of the deformed and roughened rotating band near the base *tends* to make refinements of this nature useless, it is firmly believed that such a turned-down base would be decidedly worth while. This matter will be discussed more fully under the subject of "Shell Tracers".

The character of the closed-in base, just mentioned, can readily be seen from Fig. 11. During manufacture the base of the projectile is heated, leaving the rest cool, and is upset and forged to shape on a mandrel. Thus there is no base plug as in the "open base" projectiles, shown in the same sketch. It

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\* Because of its interest in this connection, there is included in the "Professional Notes" of this number of the JOURNAL a description of "An Improved Form of Projectile."—*The Editor*.

is easy to see that the closed-in base is better adapted to withstand the shock of discharge, as it involves the principle of the arch instead of that of the beam. This would finally result in one of three things:

- a. For equal strength of base, a larger cavity;
- b. For equal strength of base, stronger projectile at other points;
- c. For equal thickness of base, greater factor of safety. There being but one threaded surface instead of the usual two, the powder gases would be less liable to force their way into the cavity and the use of our troublesome base covers might

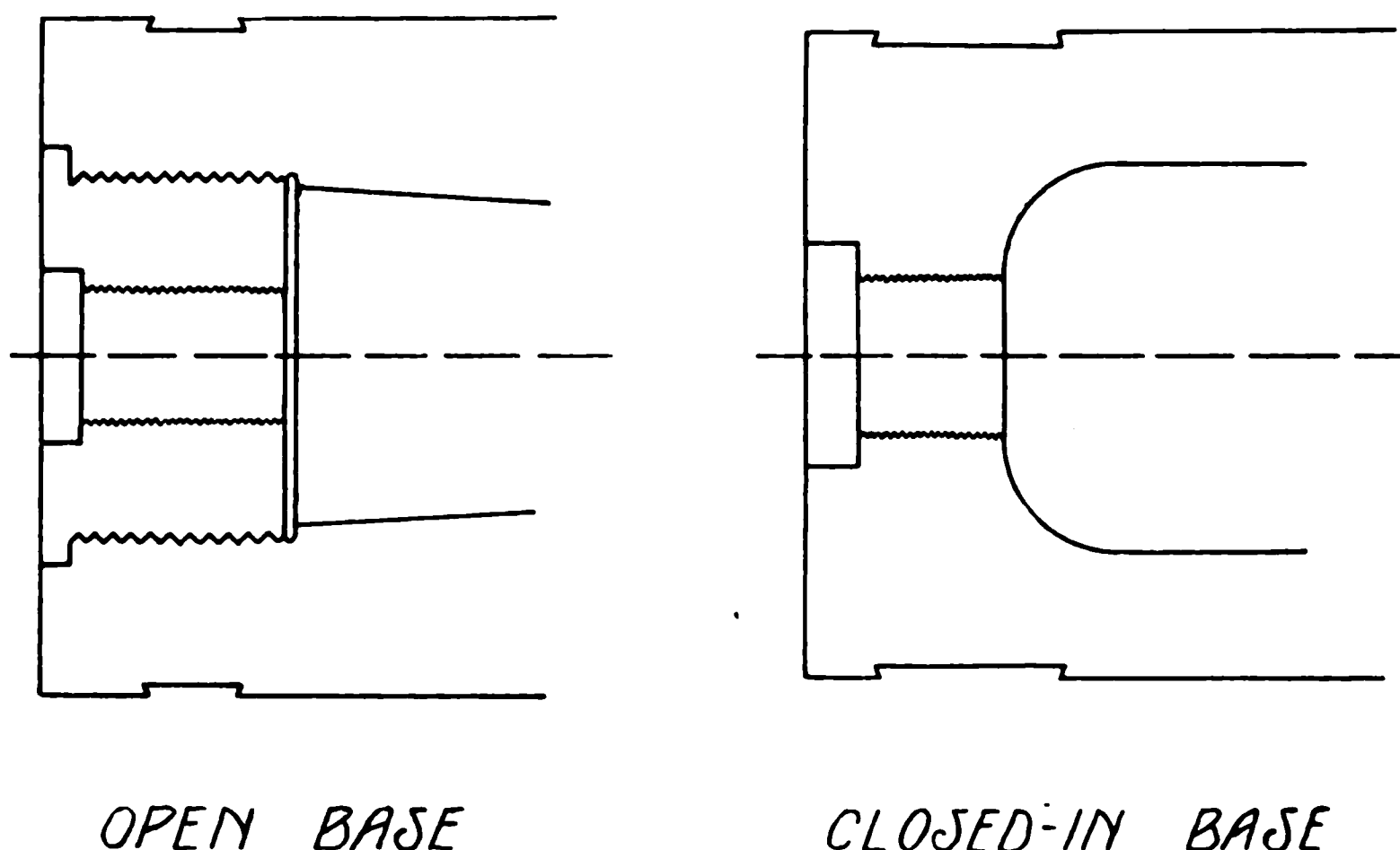


FIG. 11.

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be abolished. This may seem to be a small item, but in time of war it would mean one less thing to be considered. It is probable that the cost of forming this base would not exceed that of supplying the base plugs that are now necessary. The only disadvantage in using a closed-in base lies in the *possibility* that it would render shell filling more difficult, and even if this were a fact, it is not of sufficient importance to outweigh the many good points of such a base. This form of base has been adopted for our 3-inch projectiles for some years, and should be continued for obvious reasons.

#### 6. SHELL TRACERS

In time of war we should be able to distinguish the splash of one gun or battery from that of another. Otherwise, with

several guns of various calibers firing at the same target, it will be impossible to make proper corrections in range or deflection. A method of doing this that is sometimes used on shipboard, relies for its efficiency upon the different sizes of splash made by, say, a 12-inch and a 5-inch gun. If a fort mounted but two calibers of guns this scheme might be of use to us in certain cases, but if the fort contains three or four batteries of various calibers, all shooting independently, the impossibility of any "spotting" programme is readily seen. Hence the evolution of the tracer, which is supposed to render visible the path taken by the projectile from a few hundred yards beyond the muzzle until the tracer is burned out or is extinguished in the sea. At present there are only two types well known to the service, the Semple night tracer which operates by causing a flare of light at the base of the projectile, and the Semple day tracer which leaves behind it a trail of lampblack and water (spray) or some similar tracer liquid contained in the shell interior.

Of course, these tracers in their present form could not be used with our war projectiles, as the projectile cavities are needed to contain the more important bursting charge. Therefore the logical solution of the problem would seem to lie in fastening the tracer case to the base of the projectile. Also, it would seem that one of the makers of pyrotechnic supplies would be able to evolve a composition which would not only produce a light bright enough to serve in a night tracer, but also give off enough smoke to permit its use in daytime as well. Objection might be made to such a tracer on the ground that the smoke from the tracer would conceal the flare from observers at the guns; but such objection has little weight, because the observer at the guns is not in the best position to observe tracer action anyway, and the smoke would not conceal the flare from an observer stationed on the flank of the battery.

To obtain the right proportion of flame to smoke, tests at night and during daylight, and also at dusk or dawn, will be found necessary. That such a composition *can* be made there is no doubt, and it *will* be evolved if made worth while to the inventor.

Now, as this tracer case is to be fastened to the base of the projectile, there seems to be no good reason why it should not incidentally serve another and very important purpose, that of reducing the atmospheric resistance to flight. This has been touched upon, under the subject of "Bases", p. 270. A

glance at Fig. 12 will show how the accomplishment of this purpose is attempted. The tracer case diminishes in diameter toward the rear. The proper law governing the most efficient shape can be determined from a study of the atmospheric stream lines previously mentioned, aided by actual experiment. It is patent that a projectile with a base of such a shape would experience far less resistance in flight than any now in use, due to the lessening of the eddy currents behind the base. This, of course, means that the velocity of the projectile would fall off with much less rapidity than at present. The retarding "drag" would be greatly lessened and the ballistic effect would be the same as that produced by an increase in the sectional

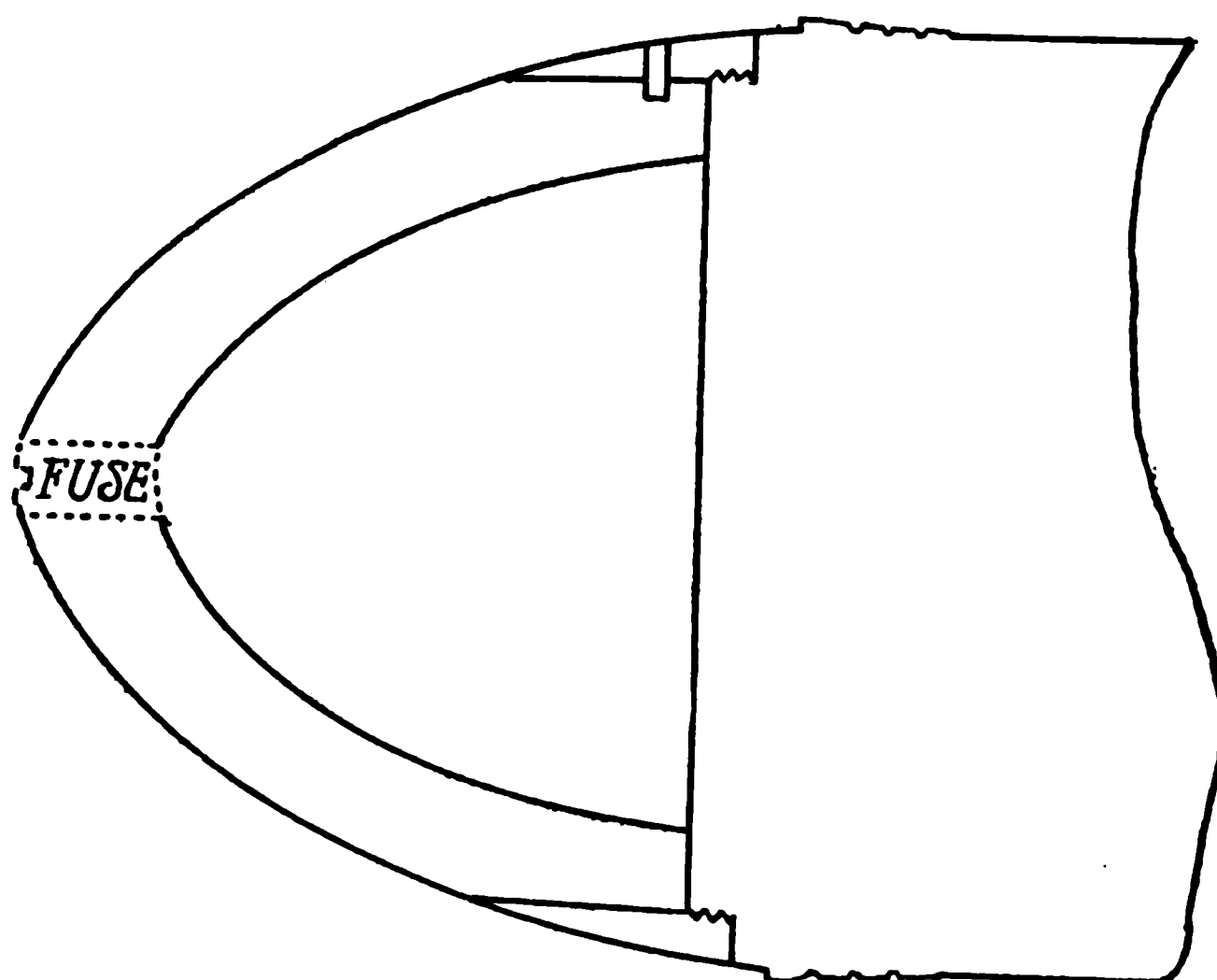


FIG. 12.

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density. The effect of this tracer case combined with that of the sharp pointed cap should produce results not far from startling.

It need not be requisite to give the tracer case an excessive thickness of wall, as it is constructed upon the principle of the arch, and therefore may be made thinner than would otherwise be necessary. Also, there is no reason why the powder pressure, upon operating the fuze, cannot be brought to bear inside the case as well as outside. This can be done through proper design of the tracer fuze and selection of tracer composition. By this means, the weight of the tracer case can be reduced to the minimum.

The rounded shape of the tracer case need not interfere with the proper ramming of the projectile, as the rammer head could easily be altered if found necessary. The shock of ramming would be less than the shock of discharge, so no harm to the tracer need be anticipated from that quarter.

Experiment should show the best method of attaching the case to the projectile, that shown in Fig. 12 is but a suggestion. If we are to continue filling and fuzeing our projectiles at posts, it is necessary that this method of attachment be of such a nature that it, too, can be performed expeditiously by post labor. The method shown in Fig. 12 involves the use of a forged steel ring permanently fastened to the tracer case, with a female thread (left handed) for attachment to the projectile. The illuminating compound, if furnished in a compressed cake, could be inserted before attachment to the projectile; or, if furnished in a powder form, could be inserted through the tracer fuze hole after attachment. As shown in Fig. 9, a lead base cover could be used as at present, the tracer case clamping it firmly to the base without additional trouble.

Even allowing for very heavy walls, it is seen that this tracer case has a comparatively great capacity, thus allowing for the large charge of the illuminating composition which would probably be necessary, considering its requirements of day and night action. It might even be large enough to warrant its use with mortar projectiles, should such use be found desirable.

Of course, if such a tracer were to be adopted for use in connection with our war projectiles it is evident that it must also be supplied for target practice projectiles, in order to obtain the same ballistic results and to permit officers and men to become thoroughly familiar with its action.

## II.

### SPECIAL TYPES OF PROJECTILES

#### A. PROJECTILES FOR TARGET PRACTICE

##### 1. *Subcaliber Practice*

Efficient projectiles for this purpose should, of course, be reasonably uniform in weight, shape, etc., in order to give the desired results. There seems to be little difficulty in securing such uniformity. In addition, however, it is important that such projectiles give a splash that is reasonably sure to be visi-





stance, should test show that the form of rotating band advocated herein would decrease erosion, it would be necessary to place these bands on our target practice projectiles as well as on the forged projectiles. It would even be better, in such a case, to put them on our target practice projectiles *first*, leaving our war ammunition until later. This for two reasons:

a. We might not use the war projectiles for years; whereas we are sure to fire a certain number of target practice rounds every year, which would result in unnecessary wear of the guns.

b. On the outbreak of hostilities, erosion would be the least of our troubles, and any battery commander would willingly ruin his battery (through erosion) provided he disabled the enemy's ships. The result would be cheap at the price.

So we may say that in general the target practice projectiles for any gun should be exact counterparts of the war projectiles for that gun in so far as exterior characteristics, weight, etc., are concerned. Therefore, the changes that may be proposed in the discussions of the latter should be made, when applicable, in the case of the former as well. The changes that would not be applicable will be perfectly apparent to the reader.

## B. PROJECTILES FOR WAR

In this case, efficiency alone is sought, cost being entirely subsidiary. When a situation can easily be imagined in which the life of a nation might depend upon the efficiency of a single projectile, the justice of this policy is apparent. The military world is ever on the alert for improvements in this line, and every nation is using its utmost endeavor to outstrip the others. All new ideas, even though they sometimes seem to violate accepted customs, are thoroughly tried out in the hope of finding something just a little bit better. For instance, many thousands of dollars were spent by our War Department in vindicating the opinion of our ordnance officers that the principle of the Gathmann and the Isham shells is fallacious.

We say that our war projectiles are designed for "maximum efficiency"; but one that would prove most efficient in one case might be comparatively worthless under other conditions. For instance, a bursting torpedo shell would create havoc in an engine room, but it would never penetrate main armor. On the other hand, a projectile designed to penetrate the maximum thickness of armor might not contain an adequate bursting charge. A glance at accurate drawings of our

A.P. shot and shell is sufficient to show the diverse paths open to the designer. The shot is designed to penetrate the maximum thickness of armor and still carry a sufficient bursting charge. In the case of the shell, penetration is sacrificed to a considerable degree in order to give the projectile a larger bursting charge.

Most practical artillerists are convinced of the desirability of having but a single projectile for each gun, that is, a compromise projectile possessing as nearly as possible the good points of both extremes and avoiding their weaknesses. The use of such a projectile would not only simplify the matter of ammunition supply, but would have other beneficial effects too numerous and obvious to mention. This subject has received more attention in the field artillery than in our branch, but it is of great importance to us also. In this paper an attempt will be made to show how, by combining in one projectile the best points recently evolved by test and theory, we may produce a projectile whose penetrative ability is about equal to that of our present A.P. shot and whose bursting effect compares favorably with that of our present A.P. shell.

### 1. *Projectiles for 3-inch R. F. Guns*

This type of gun is supposed to defend the inner waters of a harbor and the mine fields that lie within its effective range, and would, therefore, be pitted against such targets as torpedo boats, countermining launches, small boats, etc. Also, these guns might be able to render valuable assistance in case of a land attack, a fact which does not seem to have received the attention it deserves.

Hence it is seen that, in the case of the 3-inch projectile, armor piercing qualities are not needed, and that the logical design would call for a projectile carrying the maximum weight of explosive, with walls only thick enough properly to withstand the shock of discharge and to give satisfactory fragmentation. The service shell filled with high explosive is familiar to all, and therefore needs no special mention. The question is whether or not this shell is the best for the purpose. It is known that this projectile equipped with its present fuze will give good effect against torpedo boat plates, that is, our fuze is so sensitive that it will be operated when the projectile strikes a target possessing no greater resistance than that offered by the plating used on the sides of torpedo boats. In such cases the charge is exploded and a good order of detona-

tion secured with, of course, an extremely wide cone of dispersion as compared with shrapnel. The fragmentation is usually very good. From careful experiments with this projectile we may assume that the successful shots show approximately the following characteristics: point of detonation a few inches behind the plate, fragmentation about 350, and angle of dispersion about 100 degrees. From this the conclusion seems obvious that this projectile could hardly be improved for use against destroyers and similar craft, unless, perhaps, by somewhat reducing the number of fragments. But for use against troops on land or in small boats, against cable-cutting raiders, etc., this projectile would not show up to such great advantage, on account of the diminutive size of the target.

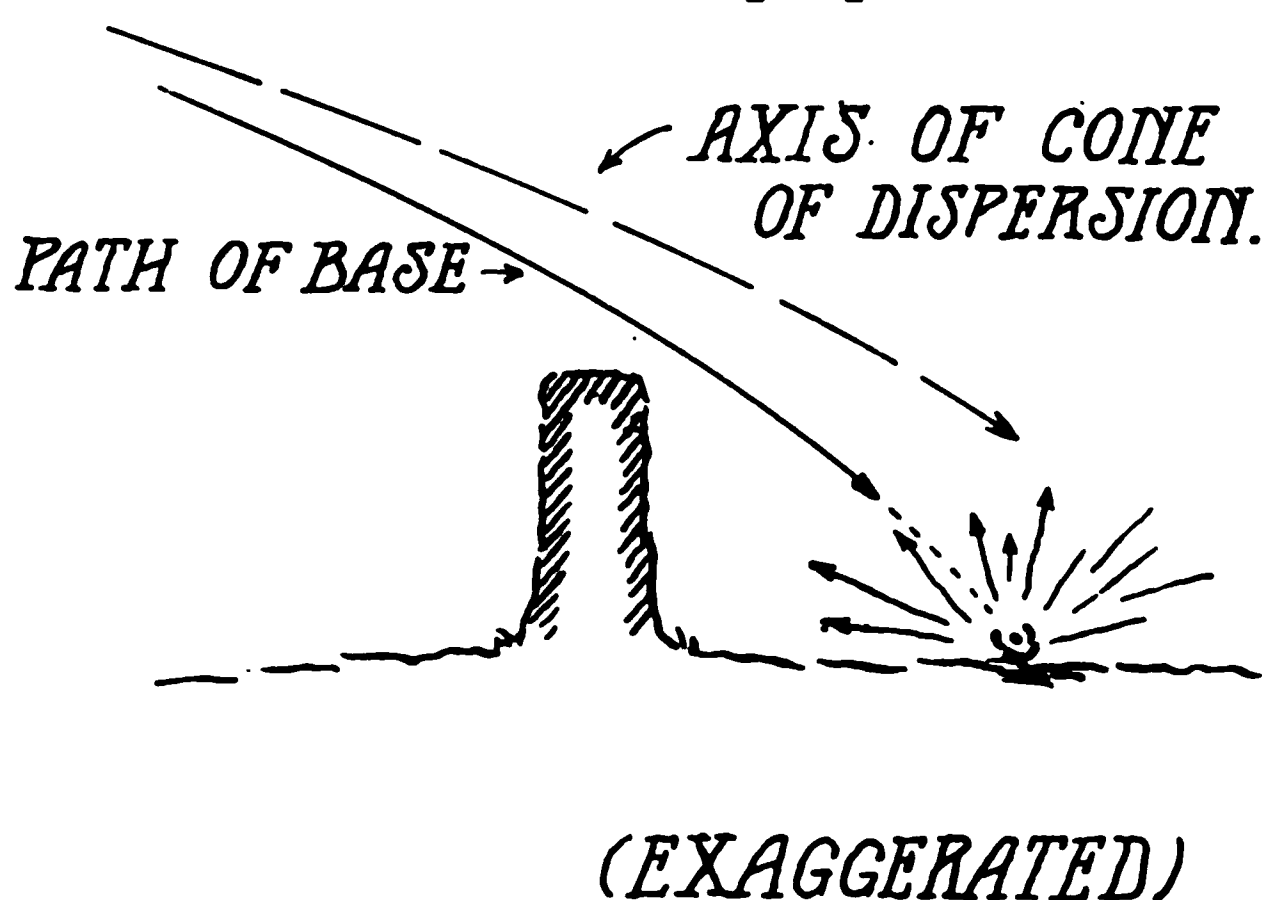


FIG. 13.

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It would seem that the logical projectile in this case is one partaking of the nature of the so-called "universal" projectile, concerning which so much and so little has been heard recently in connection with field artillery. From the official publications of the Krupp and of the Erhardt works we learn that these projectiles consist, practically, of an ordinary shrapnel with the base or the head designed to fulfil the functions of an independent shell. When the shrapnel bursts through action of the time fuze, in the one case the head is blown off and continues on in the trajectory to burst upon impact; in the other case, the base is left to act as a shell, and in this case especially the makers claim that the base bursting upon impact has superior searching effect behind walls, etc. A glance at Fig. 13 will show what is meant.

Of course we can expect nothing but glowing accounts from the makers themselves. Another report stated that these projectiles were failures. In either case it would seem incumbent upon us at least to attempt to develop this projectile and make a success of it, as all authorities seem agreed upon the great value of such a projectile.

It has been deduced that a single well adjusted shrapnel searches a front of from twenty to twenty-five yards and a depth of about two hundred yards. About one-third of all bullets at all ranges are "effective". Bursts on graze, unless short and within ten yards of the target, are of no practical effect. Tests of time train fuzes a few years ago showed that they wasted thirty per cent of the shots, about twenty per cent reaching the ground before bursting, and the remainder bursting too high.

Such results would not be acceptable or permissible in coast artillery work. The fault lies in the fuze; the shrapnel projectile itself is well suited to its purpose. Of course, its most ardent supporters do not claim it to be efficient against earthworks and similar targets; but this weakness is remedied to a great extent in the "universal" projectile. Thus it can be seen that, given an efficient fuze, the "universal" projectile would be well adapted for use by the coast artillery. Due to the manner of constructing our placements, the 3-inch R. F. gun is about our only gun capable of all-round fire. Provided with a universal projectile, the value of this gun against a land attack on the rear of the batteries is apparent.

But here we encounter trouble; for, as shown above, the present types of time train fuzes are not accurate enough for our purpose. It has been found impracticable, so far, to develop a time fuze that will give satisfaction at such comparatively high velocities as are used in our seacoast guns. That, however, does not mean that such a fuze cannot and will not be evolved. To state that a thing cannot be done is to contradict the actual records of human progress and achievement. Truly, necessity is the mother of invention, and heretofore the necessity for any given device or process has been satisfied sooner or later. Hence it would be futile to say that the time fuze will not, at some time, be perfected. There have been many attempts at a mechanical time fuze, and it would seem that the Krupp works have at last turned out a clockwork fuze (spring released by the shock of discharge) that is at least an improvement over our present type.

In this connection, notwithstanding the fact that fuzes are without the scope of this article, it might be proper to invite attention to a form of mechanical time fuze that would seem to warrant development, although, to the best of the writer's knowledge, no attempts to develop it have ever been made. We refer to a fuze operating on the flywheel principle, the idea being to install in the fuze a heavy-rimmed wheel with its axis coinciding with that of the fuze, and provided with a suitable reducing gearing, either intermittent or continuous,—the whole, of course, being specially designed to withstand the shock of discharge. Upon discharge, the projectile would take the rifling and start rotating, while the heavy rimmed miniature flywheel would tend to remain stationary until friction made it start revolving at a gradually increasing velocity. The effect would be the same as if the projectile were at rest and the wheel were given a corresponding initial rotational velocity which would slowly decrease due to friction. Assuming the I. V. for our 3-inch B. L. rifle to be 2600 f.s., the initial rotational velocity of the projectile is four hundred and sixteen turns per second, and this velocity falls off very slowly. If, through poor powder or other cause, the I. V. should decrease, the rotational velocity of the projectile would decrease correspondingly, thus automatically decreasing the rapidity of action of the fuze. The effect of head or rear winds would be taken care of in obvious ways, as at present. The errors of such fuzes would be dependent entirely upon the variation in the friction experienced by the flywheels in different projectiles. It would seem to be no more difficult to standardize this influence and secure uniformity than it has been to standardize our time trains.

Fundamental objection might be made to the use of shrapnel or similar projectiles in any of our fixed armament, even were a proper fuze available, on the ground that they would be inefficient against such targets as destroyers. This objection has some weight, as can be proved by the fact that battleships are discarding the 3-inch for larger weapons. As a matter of fact, Japan and Germany have always kept their 6-inch anti-torpedoboat weapons, and England's newest ships also mount them. The *Oklahoma* will carry twenty-one 5-inch guns. The idea seems prevalent in naval circles that, due to the enormous increase in size of destroyers, a heavier gun must now be used against them. Of course, a ship cannot afford to take chances in such a matter, which fact has an appreciable bear-

ing on the case. But if our 3-inch gun is useless against large destroyers anyway, why not develop its maximum efficiency in other directions, that is, against small boats, landing parties, attacks by land, etc.? This means the use of a universal shell.

On the other hand, if our 3-inch rifle is still efficient, there can be no objections against the use of a universal projectile, because, disregarding the other fragments of such a projectile, the head or base would easily penetrate the plating of a destroyer and would create considerable damage wherever it burst. The effect of the head alone would, of course, be less than that of a 3-inch H. E. shell, but it is believed that the total effect of the projectile would be superior.

But, as we have shown above, in view of the present status of the fuze problem, we must satisfy ourselves with the use of a high explosive shell, at least for the present. Meanwhile we should bend our energies toward the development of an efficient time fuze, and when we have reached this goal, we should furnish our secondary armament with an efficient universal projectile.

When we say that we must keep our present H. E. shell, we do not mean keeping it in its present form. In view of our previous detailed discussion of the various parts of a projectile, we shall merely list here the changes advocated in the case in hand, referring the reader to previous pages for the reasons for proposing such changes.

Changes to be made in 3-inch H.E. shell:

- a. Ogival radius to be at least five calibers.
- b. Fluted cavity, to increase capacity or strength.
- c. Rotating band to be widened to one inch.
- d. Day-and-night tracer to be used, incidentally decreasing atmospheric "drag".

## 2. *Projectiles for 6-inch B.L.R.*

These guns, belonging to the "intermediate armament," are ordinarily used to attack unarmored vessels, but may find their most important use in connection with guns of the primary armament in attacking armored ships. Here they would produce the "rain of shell" found so effective by the Japanese. They are also used to protect such parts of the mine fields as may be beyond the effective reach of the secondary armament. For the first task mentioned, a high explosive shell would be a proper solution. For the second also, the shell would seem to be the logical result, because in no instance could a 6-inch shot

penetrate the main armor of a ship. For protecting the mine fields, considering the class of craft likely to be employed, a 6-inch universal projectile presents a very attractive proposition, but in its present state of development cannot be utilized. So the logical projectile would seem to be one partaking more of the characteristics of the shell than of the shot.

In this connection the following table is instructive:—

<i>Projectile</i>	<i>Bursting charge, pounds</i>
6-inch A.P. Shot . . . . .	2
6-inch A.P. Shell . . . . .	5
6-inch Rendable Shot . . . . .	3.3

When we realize that the rendable shot, due to improved methods of manufacture, better distribution of metal, etc., has armor piercing qualities equal to those of the A.P. shot, while its bursting effect approaches that of the A.P. shell, we can appreciate the view of those who favor having but one kind of projectile for each gun. It will be noted that the bursting charge for the rendable shot is nearly double that for the A.P. shot. This proportion would remain approximately the same if all our projectiles were equipped with the long pointed cap, tracer case, etc. Of course, the improved material of the rendable shot has some effect upon the marked efficiency shown by it. This, however, is a secret of the manufacturer and is not available for publication.

The writer is therefore in favor of a 6-inch projectile possessing the following characteristics:

- a. General design approximating that of F.-S. Rendable Shot;
- b. A closed-in base;
- c. Tracer case, day and night action, attachable to base;
- d. Rotating band two inches wide;
- e. Slightly greater ogival radius and a snubbed point;
- f. Long pointed cap;
- g. Fluted cavity.

A general idea as to the projectile the writer proposes can be obtained from the rough sketch on page 285.

### 3. *Projectiles for 12-inch B.L.R.*

Under this head, as representative of the primary armament, are included the 14-inch and the 16-inch B. L. rifle, and also, according to our drill regulations, the 8-inch and the 10-inch rifles. According to modern theories, it will rarely be



The beginning of the Turkish disaster—F-4, May 1, 13.  
 Causes of the late Turkish defeat—US-30, March-April, 13.  
 The crisis in the Balkan League—Sd-1, April 5, 13.  
 The eastern question, and the European war—C-2, February, 13.  
 The fleet demonstration against Montenegro—Sd-1, April 12, 13.  
 A glance at the campaign in Thrace—F-4, April 15, May 1, 13.  
 The Greek operations in Epirus—UK-13, April, 13.  
 The importance of Adrianople as a fortified place—Ar-1.5, February, 13;  
     Sp-3, January 25, 13.  
 Italian-Greek disagreement—Sd-1, April 19, 13.  
 The Italian-Turkish war—US-59, March, 13; Po-4, January, 13.  
 The navy in the Italo-Turkish war—(1911-1912)—F-4, April 15, 13.  
 One of the lessons of the war in the East—Sp-3, February 25, 13.  
 Renewal of the Balkan war—I-4, February, 13.  
 The Roumanian-Balkan disagreement—Sd-1, April 5, 13.  
 Scutari—Sd-1, May 3, 13.  
 A second lesson from the war in the East—Sp-3, March 10, 13.  
 The Turko-Balkan war—Co-1, January, 13.  
 The Turkish disorganization—Sp-3, April 10, 13.  
 The war in the Balkan Peninsula—UK-13, March, 13.  
 The working of system (mobilization of the Bulgarian army)—Sp-3, March  
     25, 13.

#### HORSES

The army remount question—US-39, March, 13.  
 Horse shoes of the Russian army—US-39, March, 13.  
 The heavy weight cavalry horse—F-11, February, 13.  
 The veterinary service of the remount depot—Be-1, March 16, 13.  
 Sea transportation of horses—US-27, January-March, 13.  
 The trotter as a cavalry horse—US-39, March, 13.  
 The useful Morgan horse—US-39, March, 13.

#### HYGIENE AND SANITATION

Footwear and footcare—US-5, April 24, 13.  
 Physical training in the army and navy—UK-26, April, 13.  
 Prevention of mosquito breeding—US-56, March, April, 13.  
 Pure water for an army in the field—Br-1, March, 13.  
 The sanitation of construction camps—US-56, April, 13.

#### INFANTRY

Communication in action within an infantry regiment—Au-3, No. 2, 13.  
 Cyclist companies—F-13, April 15, 13.  
 Instruction of French infantry—Pe-1, March 15, 13.  
 Leading a unit (infantry) to combat—Pe-1, March 15, 13.  
 The peace training of infantry—US-30, May-June, 13.  
 The use of cyclist companies—Sd-1, February 1, 13.

#### LAW

##### *International:*

Contraband of war according the declaration of London—F-14, December, 12,  
     January, February, 13.  
 Exemption from Panama tolls—US-3L, April, 13.



means referred to have been previously discussed, and will therefore be passed over here with mere mention.

a. As penetrative ability is a function of the remaining velocity, any conservation of the latter will result in a corresponding increase of the former, especially at the outer ranges where it is most important. This is accomplished by the use of a long pointed cap, and by the addition to the base of the projectile of a tracer case designed, incidentally, to prevent atmospheric drag.

b. Strengthening the projectile near the bourrelet by proper design of cavity and use of ribs therein. (Many claim that buckling at the bourrelet wrecks more projectiles than does the breaking down of the point.)

c. Slightly snubbing the point of the projectile to increase the strength thereof.

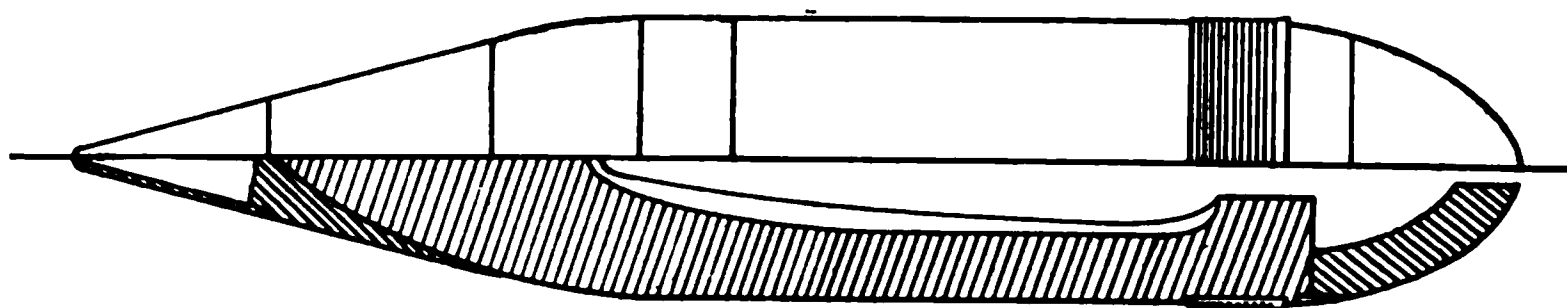


FIG. 14.

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Sketch showing general appearance of proposed projectile for 12-inch B.L.R.

Other characteristics that should be possessed by this projectile are:

- (1). Closed-in base.
- (2). Wider bourrelet, lessening the battering of the bore.
- (3). Rotating band four inches wide with a lip at the rear. This band should never allow the projectile to back out of the centering cone as has frequently occurred when the gun is tripped.
- (4). Bursting charge about three per cent or more of weight of projectile.
- (5). Shearing ring in projectile behind rotating band.

#### 4. *Projectiles for Mortars*

Mortars employ high angle fire and are used at all ranges to attack the decks of ships with high explosive shell. (Par. 7, C.A.D.R.)

Our newest battleships, of the *Nevada* class, will have two protective decks, the upper or gun deck being flat and 3-inches thick, the lower one being turtle-backed and 1.5 inches thick on the flat. Such armor, in addition to ordinary deck plating,

would seemingly present quite a problem. It is doubtful if our torpedo shell would produce the desired results, as its walls are extremely weak. At the present stage of battleship development, it would seem that the protection of the *Nevada* will not be surpassed for some time to come, and that we shall hardly encounter a more difficult target, at least as far as mortar fire is concerned. So, if our present mortar projectile is strong enough to penetrate such protection, it would seem to be strong enough properly to fulfil its purpose. To see that such is actually the case we have but to glance at the test requirements of our D.P. shell, which are required to penetrate a 4.5-inch N.S. protective deck, with a 60° angle of impact. If two out of three projectiles selected at random pass this test, the lot is accepted. In view of the increase in thickness of the protective deck, it might be well to make this test a trifle more severe; but the various improvements in the minor details heretofore described should more than counterbalance such increased severity of test.

The other projectile used with mortars, the torpedo shell, is not required to pass an armor piercing test. If two out of three test projectiles properly withstand the shock of discharge and are recovered from the sand butt in condition for effective bursting, the lot is accepted. The principle of this projectile is obvious. It is not known whether or not the authorities have definitely discontinued this projectile, but the propriety of such action seems to be maintained by most practical artillerymen, on the ground that the D.P. shell serves all necessary purposes. If one of the latter struck in the same place as a torpedo shell, would the difference in effect counterbalance the disadvantages involved? The explosive action of the torpedo shell would be the more powerful, but the D.P. shell would have a better chance of penetrating to the vitals of the ship. Considering this and the good fragmentation obtained from the latter, would it be worth while to keep the torpedo shell?

The ideal condition would be one in which we could use the same projectile indiscriminately in either the mortar or the gun. This, however, under our present conditions, would hardly make for the greatest efficiency, due to the fact that the mortar projectile need not be so strong, and we would therefore make a useless sacrifice of bursting effect.

In view of all the circumstances of the case, it would therefore appear that the logical projectile would be one designed on the general lines of our present D.P. shell, with such of the

improvements heretofore mentioned as may be applicable. This would result in a projectile entirely different from that advocated for use with the 12-inch rifle, being appreciably weaker and containing a correspondingly increased bursting charge.

Probably the shell tracer would not be used unless experiment should indicate its advisability. However, considering the size of the tracer case that could be used, there would probably be little difficulty in obtaining one that would give satisfaction. And in any event, its use would avoid the necessity for base covers and, for the same range, would permit a reduction in the powder charge.

Considering the character of the mortar, it is not evident that wide rotating bands are essential, although they would probably prove desirable. But in any case, the shape of the band should be modified. Due to the angles of elevation at which mortars are fired and the consequent liability of the projectile to drop back out of its seat onto the powder charge, it is essential that the projectile when once rammed home should stick to its seat, and that the conformation of the band should be such as to insure this permanency of position. If we assume a band two inches wide (three fourths of an inch wider than at present) an acceptable form would seem to be presented by the rear half of the band shown in Fig. 9.

To recapitulate, the single proposed projectile for our mortars would have the following general characteristics:

- a. Long pointed cap, to reduce air resistance;
- b. Tracer case (if warranted by experiment) for reasons stated;
- c. Bursting charge about six per cent of weight of projectile;
- d. Ribbed cavity;
- e. Closed-in base and no base cover;
- f. Band moved to rear as far as experiment shows allowable.

### III.

#### CONCLUSION

The writer is fully aware that in the preceding discussion are advanced some radical ideas. It is not expected, in some cases, that they will meet with the approval of all artillerymen. But then, how would the idea of a capped projectile have struck an artilleryman a few years ago? Yet the cap is one of the

greatest improvements of recent years, and is so accepted throughout the military world. Revolutionary ideas must not be condemned until actual experiment shows them to be worthless. Many devices that are in efficient operation today were at first said to be contrary to "common sense".

We *must* improve; as soon as we stand still we commence to fall behind in the race. Therefore, it is high time to look about us and to find the next possible improvement that can be applied to our projectiles. Some of the improvements suggested herein have actually proved their worth, others are based upon theory alone. Among the latter is the writer's idea of utilizing a tracer case to lessen the atmospheric resistance encountered by the projectile. He is confident that actual test of this device will demonstrate its value.

In connection with the rotating bands proposed herein, reference might be made to our 14-inch guns. It will be remembered that the *raison d'être* of this type was the excessive erosion in the 12-inch gun using 2500 f.s. initial velocity. The advisability of adopting a larger caliber with low velocity was the subject of an energetic controversy at the time, and some of the discussion was published in the JOURNAL. There were several reasons for opposing the adoption. First and foremost, it seemed like a deliberate step backward. Ever since the first days of artillery the watchword had been "Higher velocities!" (Larger caliber guns have been built in the past than any that are now in use, so it is seen that the struggle for the maximum caliber is at present a subsidiary matter.) Gradually we had worked up to 2500 f.s. for our largest guns, and suddenly we must go back to where we had been several years before. Why? Because of erosion. Now erosion is a subject concerning which many people have advanced various hypotheses but for which nobody has put forth an authoritative explanation. So, before taking this step back into the dark ages of low initial velocities, was it not wise to attempt some other remedy?

It was claimed that our 12-inch guns would be useless after sixty shots or so, when employing 2500 f.s. I. V., and after two hundred rounds when employing 2250 f.s. How is it, then, that Krupp guns (according to seemingly authentic reports) after firing over three hundred rounds are as accurate as at first? Also, a certain battery in our own service, one that has fired over two hundred rounds, by using wide banded projectiles is now "as accurate as the powder". Of course, after

such extended use, these guns are bound to lose in ranging ability; but it is maintained that they do *not*, as a rule, fall off in accuracy to any such degree as is sometimes stated.

The object of these remarks is to invite attention to the form of rotating band advocated herein, a wide band, cylindrical and not conical, as one which, when perfected through experiment, might obviate the necessity for the above mentioned drastic method of treating the subject of erosion. We know that wide bands are efficient, not only in badly eroded guns, but also in new guns. To be sure, they are bound to copper the bore, but that defect is comparatively innocuous. The writer has seen no data bearing upon the number of rounds that can be fired with accuracy, when the wide band is used with velocities as high as 2500 f.s. If the accuracy life of the gun is found to be raised to two hundred rounds or more, there would seem to be little excuse for the 14-inch gun. Of course, if the probable zone for a 12-inch gun is greatly widened after any number of shots, the value of the gun is correspondingly decreased. But, on the other hand, if the gun simply experienced a decrease of ranging ability with no appreciable decrease in accuracy, the simple operation of making an arbitrary correction would keep the gun approximately at its pristine point of efficiency. It might be stated, in passing, that this method was used during target practice at the battery mentioned above, with good results. The correction amounted to over two hundred yards at mid-range.

As was stated at the beginning of this paper, no attempt has been made to treat of secret alloys of steel, the proper adjustment of the center of gravity of the projectile, the laws governing the thickness of wall at various points, or, in fact, any matter that refers primarily to the ultra-technical points of design or manufacture. We leave that to the professional designer, the manufacturer, and those in charge of experimental firings. We know that the position of the center of gravity and also the position of the rotating band have considerable bearing upon the accuracy of the projectile. But these problems depend upon experiment for their solution. We have endeavored to speak simply as a practical artilleryman, albeit one who has been out of touch with the artillery for two years and hence is not thoroughly conversant with all the minor developments occurring within that time. For this reason, some of the ideas set forth herein may have been tested and their value or their lack of merit already established in the reader's mind.

The reorganization of our national forces and providing officers of reserves—  
Be-1, May 4, 13.

Our reserve system—US-30, March-April, 13.

#### SCHOOLS

The Army Service Schools—US-27, January-March, 13.

The Army Signal School—US-30, May-June, 13.

The Belgium cavalry school at Ypres—Be-1, April 13, 27, 13.

Competitive entrance examination to the staff college in 1913 (tactical problem)—F-4, March 15, 13.

The military education of youth—C-1, April, 13.

Military schools for recruits—Sp-3, January 25, 13.

Naval school for Portugal—Po-1, January, 13.

On the military historical study of officers—G-5, No. 13, 12.

Portuguese war college—Po-4, November-December, 12.

Post-graduate department, Naval Academy—US-7, March 29, April 5, 13.

The school of gunnery, Shoeburyness—UK-3, April, 13.

The school for military gymnastics at Joinville-Le-Pont—Po-4, January, 13.

Separation of the schools for artillery and engineers, in France—Sp-3, February 10, 13.

The training of regimental officers of detached units—UK-5, January, 13.

Two early proposals for naval education—US-59, March, 13.

#### SEARCHLIGHTS

Application and use of the searchlight—Sd-4, No. 1, 13.

Projectors on warships—I-4, February, 13.

#### SIEGE ARTILLERY

Fortress artillery and the service of production and conservation of matériel in the principal armies—I-3, December, 12.

Siege guns in the fall maneuvers of the French army—G-5, December 31, 12.

#### SIEGE OPERATIONS

Defense of fortified places—C-1, April, 13.

History of siege warfare—F-12, February, March, 13.

Siege warfare—UK-21, May, 13.

#### SIGHTS

Adjustment of telescopic sights—Po-4, November-December, 12.

#### SIGNALLING, VISUAL

The development of optical telegraphy for military purpose from the beginning to the present time—G-8, January, 13.

Transmission of orders during the naval battles of the Russo-Japanese war—US-59, March, 13; C-2, Jan., 13.

#### SMALL ARMS

The Brixia automatic pistol—Be-2, January-February, 13.

The cartridge (small arms) of the future—Sp-3, April 10, 13.

An extemporized hand grenade—UK-21, April, 13.

The form and use of the saber—US-30, March, 13.

Machine guns and automatic rifles—Ar-2, March, 13.

# NOTES ON INTERIOR BALLISTICS

BY COLONEL JAMES M. INGALLS, UNITED STATES ARMY (RETIRED)

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## I.

### MORE ABOUT SIR ANDREW NOBLE'S EXPERIMENTAL FIRINGS WITH A SIX-INCH GUN

These firings, made about twenty years ago, still afford the most reliable and, in some respects, the most valuable data accessible to a student of interior ballistics, because they give the actual measured velocity of a projectile at sixteen points in the bore and also at the muzzle, for various kinds of smokeless powders and with different densities of loading. Six of these velocities were measured between the starting point and a travel of two feet, or just beyond the position of maximum pressure; and are thus particularly valuable in a study of the interior ballistics of the gun. The writer of this note has already made extensive use of these data in his various publications, and it may seem as if the subject has been exhausted. But until recently the measured velocities were obtainable by the writer only by measuring them from the published velocity curves drawn to a small scale suitable to an octavo page. Moreover, in the published diagram there are seven velocity curves proceeding from the same origin, making it impossible to take off the velocities with any precision, especially at the plugs near the starting point. Recently the writer has been favored by Colonel A. G. Hadcock, one of the managers of the Elswick works where the firings were made, and himself an eminent writer on ballistics, with an exact copy of the original drawing of the cordite and ballistite curves, four in number, on a large scale "which was made direct from the measured velocities, probably, however with slight corrections here and there." This drawing has made it possible to get the velocity at each of the sixteen plugs with an error of less than five feet. It will probably be admitted that the close agreement between the computed and measured velocities for



more than ninety per cent of the entire travel of the projectile illustrates the great accuracy with which the Noble chronograph measures extremely small intervals of time.

TABLE B

Computed velocities, pressures, and pounds of powder burned in an English 6-inch gun, for certain given distances traveled by the projectile, and comparison of computed velocities with measured velocities. Charge 20 lbs. of ballistite made into 0.3 inch cubes. Density of loading .04. Weight of projectile 100 lbs. Density of powder 1.56. Reduced length of initial air space, ( $z_0$ ) 3.0332 ft.

No. of plug	Distance traveled in feet $u$	$u = \frac{x}{z_0}$	Measured velocity f.s.	Computed velocity f.s.	Measured-computed	Computed pressures lbs. per sq. in.	Powder burned ( $y$ ) lbs.	Remarks
1	0.08	0.0264	60	139	—79	19315	3.444	
2	0.28	0.0923	240	339	—99	30956	6.100	
3	0.48	0.1582	390	489	—99	35264	7.704	
4	0.88	0.2901	605	716	—111	39013	9.696	
—	1.0617	0.35	—	801	—	39262	10.376	Maximum pressure. Mean crusher-gauge pressure said to be 33936 lbs. This is certainly erroneous.
5	1.28	0.4220	800	893	—93	39189	11.088	
6	2	0.6594	1070	1138	—68	36582	12.834	
7	3	0.9890	1328	1385	—57	32056	14.418	
8	4	1.3187	1523	1569	—46	27883	15.502	
9	6	1.9781	1788	1831	—43	21415	16.926	
10	8	2.6375	1975	2011	—36	16920	17.800	
11	12	3.9562	2235	2248	—13	11340	18.816	
12	16	5.2750	2400	2398	2	8142	19.338	
—	16.6	5.4728	2416	2416	0	7782	19.392	
—	21.6	7.1212	2537	2536	1	5539	19.704	
13	22	7.2531	2548	2544	4	5404	19.724	
14	28	9.2312	2640	2640	0	3864	19.894	
—	34.1	11.2420	2713	2710	3	2911	19.972	
15	36	11.8687	2732	2728	4	2695	19.986	
16	44	14.5061	2790	2789	1	2040	19.994	
—	46.6	15.3640	2806	2806	0	1891	19.999	Muzzle. Powder practically all burned, though not theoretically until $u = 48.12$ feet.

The tables B, C, and D, sufficiently described by their captions, are of some interest, showing, as they do in a striking manner, the effect of the form of the grain upon the velocities and pressures in the gun. All the elements of



loading were the same in both cases, and both charges were practically burned in the gun. The grains of powder of Table B (ballistite) were cubes 0.3 inch on a side; while those of Table C (cordite) were long slender cylinders 0.3 inch in diameter. The initial surface of combustion of the former charge was, therefore, fifty per cent greater than the latter, and from this we should expect that the pressures and velocities due to the charge of ballistite would be greater at first than those produced by the same charge of cordite, even though this latter is the stronger powder, giving a muzzle velocity of 2914 f.s. to the former's 2806 f.s. The force characteristic of the 0.3 inch cordite was found (Interior Ballistics, page 124) to be 2521 lbs.; while that of 0.3 inch ballistite was 2338 (page 143).

TABLE C

Computed velocities, pressures, and pounds of powder burned in an English 6-inch gun for certain given distances traveled by the projectile, and comparison with measured velocities. Charge 20 lbs. of 0.3 inch cordite. Density of loading 0.4. Weight of projectile 100 lbs. Density of powder 1.56. Reduced length of initial air space, ( $z_0$ ) 3.0332 ft.

No. of plug	Distance traveled in feet $u$	$x = \frac{u}{z_0}$	Measured velocity f.s.	Computed velocity f.s.	Measured-computed	Computed pressures lbs. per sq. in.	Powder burned ( $y$ ) lbs.	Remarks
1	0.08	0.0264	60	129	—69	16657	2.814	
2	0.28	0.0923	245	316	—71	27508	4.916	
3	0.48	0.1582	395	458	—63	31973	6.266	
4	0.88	0.2901	615	681	—66	36414	8.132	
5	1.28	0.4220	810	856	—46	37291	9.446	Maximum pressure. Mean crusher-gauge pressure, 37184 lbs.
6	2	0.6594	1090	1102	—12	36076	11.162	
7	3	0.9890	1370	1357	13	32733	12.834	
8	4	1.3187	1570	1551	19	29274	14.014	
9	6	1.9781	1847	1833	14	23466	15.730	
10	8	2.6375	2041	2032	9	19129	16.854	
11	12	3.9562	2302	2301	1	13332	18.280	
12	16	5.2750	2472	2474	—2	9712	19.086	
—	16.6	5.4728	2495	2495	0	9285	19.178	
—	21.6	7.1212	2632	2633	—1	6493	19.696	
13	22	7.2531	2636	2642	—6	6316	19.726	
14	28	9.2312	2747	2747	0	4188	19.974	
—	31.3	10.3190	—	2787		3331	20.000	Powder all burned.
—	31.1	11.2420	2821	2816	5	3000	—	
15	36	11.8687	2840	2834	6	2807	—	
16	44	14.5061	2897	2897	0	2189	—	
—	46.6	15.3640	2914	2914	0	2038	—	Muzzle.

These numbers are proportional to the work done on the projectiles, that is, to the square of the respective muzzle velocities. Thus we have the proportion

$$2521 : 2338 :: (2914)^2 : (2806)^2$$

TABLE D

Table of the differences of the computed velocities and pressures produced by equal charges of cordite and ballistite in a 6-inch gun for certain given travels of projectile. Also differences of powder burned. Charge 20 lbs. Weight of projectile 100 lbs.

Travel in feet <i>u</i>	Computed velocity for cordite f.s.	Computed velocity for ballistite f.s.	Difference	Computed pressure, cordite	Computed pressure, ballistite	Difference	Pounds of cordite burned	Pounds of ballistite burned	Difference
0.08	129	139	—10	16657	19315	—2658	2.814	3.444	—0.630
0.28	316	339	—23	27508	30956	—3448	4.916	6.100	—1.184
0.48	458	489	—31	31973	35264	—3291	6.266	7.704	—1.438
0.88	681	716	—35	36414	39013	—2599	8.132	9.696	—1.564
1.28	856	893	—37	37291	39189	—1898	9.446	11.088	—1.642
2	1102	1138	—36	36076	36582	— 506	11.162	12.834	—1.672
3	1357	1385	—28	32733	32056	677	12.834	14.418	—1.584
4	1551	1569	—18	29274	27883	1391	14.014	15.502	—1.488
6	1833	1831	2	23466	21415	2051	15.730	16.926	—1.196
8	2032	2011	21	19129	16920	2209	16.854	17.800	—0.946
12	2301	2248	53	13332	11340	1992	18.280	18.816	—0.536
16	2474	2398	76	9712	8142	1570	19.086	19.338	—0.252
16.6	2495	2416	79	9285	7782	1503	19.178	19.392	—0.214
21.6	2633	2536	97	6493	5539	954	19.696	19.704	—0.008
22	2642	2544	98	6316	5404	912	19.726	19.724	0.002
28	2747	2640	107	4188	3864	324	19.974	19.894	0.080
34.1	2816	2710	106	3000	2911	89	20	19.972	0.028
36	2834	2728	106	2807	2695	112	20	19.986	0.014
44	2897	2789	108	2189	2040	149	20	19.994	0.006
46.6	2914	2806	108	2038	1891	147	20	19.999	0.001

The velocities, pressures, and weights of powder burned given in Table B, for ballistite were computed by the formulas given on pages 140 and 142, Interior Ballistics. It will be observed that *k* must be multiplied by 20 to give the number of pounds of powder burned. This gives

$$y = [4.18740 - 10] \frac{v^2}{X_2}$$

The computations for 0.3 inch cordite (Table C) were made by the following formulas whose constants are given on page 124, Interior Ballistics, viz.:

From  $u = 0$  to  $\bar{u} = 31.3$  ft.:

$$v^2 = [6.54986] X_1 \{ 1 - [8.80138 - 10] X_0 \}$$

$$p = [4.80822] X_3 \{ 1 - [8.80138 - 10] X_4 \}$$

$$y = [4.15461 - 10] \frac{v^2}{X_2}$$

From  $\bar{u} = 31.3$  to muzzle:

$$V^2 = [7.14612] X_2$$

$$P = \frac{[4.92766]}{(1+x)^3}$$

The constants entering into these formulas depend only upon two measured velocities, one at a travel of 16.6 feet and while the powder was still burning; the other at the muzzle after the charge had been consumed. These two measured velocities are the only experimental data employed. The rest is pure theory. In view of these facts the comparison of the computed with the measured velocities given in Table C is rather remarkable. From a travel of two feet up to the muzzle, a distance of 44.6 ft., the differences are, with two exceptions, less than one per cent of the measured velocities, and in most cases are less than one-fifth of this. Moreover, the agreement between the computed maximum pressure and the mean crusher gauge pressure is equally remarkable. The agreements between the measured and computed chase velocities for a charge of 22 lbs. of 0.35 inch cordite and also for a charge of 27.5 lbs. of 0.4 inch cordite (not given in this Note) while not quite so close, are equally remarkable.

With regard to the measured velocities at the first five plugs, it will be observed that the increments of velocity from plug to plug are very nearly the same for both the measured and the computed velocities. So that, if we assume that the velocity at the first plug, after a travel of 0.08 ft., is the same as the computed velocity, namely, 129 ft., the other measured velocities would become, by adding the observed increments, as in the table on the following page, where the computed velocities are also given for comparison.

The difference between the observed and the computed velocities for  $u = 0.08$  may be accounted for by the work

required for forcing the projectile, which was not taken into account in deducing the velocity formula. As the way in which this formula was deduced makes the computed and the measured velocities the same when  $u = 16.6$  ft., this initial difference is made up gradually to this point and completely from this point to the muzzle.

$u$	Corrected measured velocities	Computed velocities	Difference
feet	f.s.	f.s.	
0.08	129	129	0
0.28	314	316	-2
0.48	464	458	6
0.88	684	681	3
1.28	879	856	23

## II.

### THE LAW OF THE VELOCITY OF COMBUSTION IN A GUN

A brilliant artillerist and West Point professor, reviewing my Interior Ballistics in the *Nation* for September 12, 1912, makes the following statement: "Too much must not be expected from Colonel Ingalls' book, for the fact is to be noted that he is limited by preferences. Setting out from the domain surveyed by Noble and Abel, he takes Sarrau for his first sign-post, and then proceeds, perhaps unconsciously, under the guidance of Siacci. We are almost of the belief that his course is thus laid because of its convenience. To illustrate: the law of the velocity of combustion in a gun is unknown, but, as it must be reckoned with, various approximations have been made." With regard to this statement I think it proper to make a few remarks and corrections.

My "first sign-post" was not Sarrau but Lieutenant (now Captain) J. H. Glennon, U. S. Navy, whose valuable paper on the subject of interior ballistics I thus noticed in the JOURNAL U. S. ARTILLERY for October, 1894, page 749: "In 1888 Lieutenant Glennon published a paper in the *Proceedings of the U. S. Naval Institute* entitled 'Velocities and Pressures in Guns' which was at once recognized by those qualified to judge as the most original and valuable paper on interior ballistics which has appeared in this country. In this paper Lieutenant Glennon deduces an original expression

for the weight of powder burned in the gun at any time as a function of the distance traveled by the projectile, and which is fundamental in the treatment of interior ballistics." The "expression" referred to is equation (13), Chapter IV, of the third edition of my Interior Ballistics. It is on this equation, which might well be called *Glennon's equation*, that a great part of my work is founded. Captain Glennon has never developed his method; indeed he appears to have dropped it entirely, and no one except myself, so far as I know, has ever taken it up. How I could have "proceeded" under the "guidance of Siacci" in my interior ballistic work, except through telepathy, I fail to see, as this distinguished *savant* has never, to my knowledge, written a word on the subject.

The "limited by preferences" of which I am accused refers to the fact that I preferred Sarrau's law of the square root of the pressure for determining the velocity of combustion in the gun to that deduced by Sebert and Hugoniot from their experiments made in 1880 with a 10-cm. gun loaded with black charcoal powder.\* "In their study of the action of this powder in the gun, guided by their experiments, they arrived at the conclusion that the velocity of combustion was proportional to the pressure. But the velocities determined by them at various positions of the projectile in the bore, have been very exactly reproduced by formulas based upon a rate of combustion proportional to the square root of the pressure."†

I gave as reasons for my preference that "the resulting formulas are easily worked, and give results which agree very well with facts." I might also have stated that the velocity and pressure formulas based upon Sebert and Hugoniot's law give results which do not agree even approximately with facts; and these, of course, were my reasons for preferring Sarrau's law. On this subject I desire to enter a little more into detail.

As soon as my attention had been called to the experiments of Sebert and Hugoniot, through a translation of their memoir, constituting "Construction Note" No. 62, Ordnance Department, I prepared an article which was published in the JOURNAL U. S. ARTILLERY, Vol. VII, 1897, in which are deduced formulas for velocity and pressure based upon their law of the velocity of combustion under variable pressure. These formulas are analogous to those given in Chapter IV, of my Interior Ballistics, and are quite as simple and as

\* *Memorial de l'Artillerie de la Marine*, 1882.

† JOURNAL U. S. ARTILLERY, Volume VII, page 62.

*Frontispice.*

*Photograph by Stephen Oriskany, Seattle.*

**H. M. BATTLE-CRUISER PRINCESS ROYAL**  
(See page 373)

out by both laws, the computed maximum pressure by the first comes out from 20 to 100 per cent greater than the mean crusher gauge pressure.

The general expression for the fraction of charge burned for any given travel of projectile by Sebert and Hugoniot's law of burning is

$$k = \frac{y}{\bar{\omega}} = \alpha \frac{v}{\bar{v}} \left\{ 1 + \lambda \left( \frac{v}{\bar{v}} \right) + \mu \left( \frac{v}{\bar{v}} \right)^2 \right\}. \quad (15)$$

Making

$$Y_2 = 1 - \frac{1}{(1+x)^{\frac{1}{n}}}, \quad (24)$$

equation (19), Chapter II, Interior Ballistics, becomes

$$v^2 = \frac{2 n g f y}{w} Y_2. \quad (8)$$

Proceeding as on page 84, Interior Ballistics, we find the general expression for velocity of projectile while the powder is burning to be

$$\frac{v}{\bar{v}} = \alpha \frac{Y_2}{\bar{Y}_2} \left\{ 1 + \lambda \left( \frac{v}{\bar{v}} \right) + \mu \left( \frac{v}{\bar{v}} \right)^2 \right\}. \quad (21)$$

*Special formulas for velocity and pressure.*—For thin, flat grains and for long cylindrical grains with axial perforation (usually called uni-perforated grains)  $\alpha$  is approximately unity and  $\lambda$  and  $\mu$  zero. For these grains (21) becomes

$$v = \frac{\bar{v}}{\bar{Y}_2} Y_2 = M Y_2, \quad (7')^*$$

by making

$$M = \frac{v}{Y_2}.$$

The velocity, therefore, for a charge of these grains, while the powder is burning, varies directly as the function  $Y_2$ .

Differentiating (7') with reference to  $x$  and multiplying by  $v$ , there results

$$\frac{v dv}{dx} = M^2 Y_2 \frac{d Y_2}{dx}$$

From equation (5), Interior Ballistics, page 81, we get

$$\frac{v dv}{dx} = \frac{g z_0 \omega p}{w} = \frac{27.68 g a \bar{\omega} p}{w} \quad (5)$$

\* The formulas distinguished by a prime refer to the correspondingly numbered formulas in Chapter V, Interior Ballistics.

Therefore,

$$p = \frac{M^2 w}{27.68 \, g a \dot{w}} \cdot Y_2 \frac{dY_2}{dx}$$

Making

$$Y_3 = Y_2 \frac{dY_2}{dx}$$

and

$$M' = \frac{12 M^2 w}{27.68 \, g a \dot{w}} = [8.12970 - 10] \frac{M^2 w}{a \dot{w}}$$

we have finally,

$$p = M' Y_3 \quad (8')$$

It is evident from (24) that

$$Y_3 = \frac{Y_2}{n(1+x)^{\frac{n+1}{n}}}$$

and therefore in terms of  $Y_2$ ,

$$p = \frac{M' Y_2}{n(1+x)^{\frac{n+1}{n}}}$$

It will be seen that the pressures by the monomial formula (8') are directly proportional to  $Y_3$ , and therefore this function must have a maximum value, which by the rule for determining maxima is found to occur when

$$1+x = \left(\frac{n+2}{n+1}\right)^n$$

Substituting this value of  $1+x$  in the expressions for  $Y_2$  and  $Y_3$  and reducing we have

$$Y_{3(\max.)} = \frac{1}{n(n+2)} \left(\frac{n+1}{n+2}\right)^{n+1}$$

Therefore by Sebert and Hugoniot's law of combustion we have by (8')

$$p_{\max.} = \frac{M'}{n(n+2)} \left(\frac{n+1}{n+2}\right)^{n+1}$$

When  $n=3$ , this last equation becomes

$$p_{\max.} = 0.027307 M'$$

and

$$x = \frac{61}{64}$$

*Formulas for velocity and pressure when  $\lambda$  is negative and  $\mu=0$ .*—Making  $\mu$  zero and  $\lambda$  negative in (21) it becomes

$$\frac{v}{v_0} = \alpha \frac{Y_2}{Y_2} \left\{ 1 - \lambda \left( \frac{v}{v_0} \right) \right\} \quad (28')$$



Solving for  $v$  and making

$$M = \frac{\bar{v}}{\lambda}, \quad N = \frac{\bar{Y}_2}{\alpha \lambda} \text{ and } Y_1 = \frac{1}{Y_2}$$

we have while the powder is burning

$$v = \frac{M}{1 + NY_1} \quad (\text{A})$$

Differentiating (A) with reference to  $x$  we have, since  $Y_1$  is a decreasing function of  $x$ ,

$$\frac{v dv}{dx} = \frac{M^2 N \frac{dY_1}{dx}}{(1 + NY_1)^3}$$

Proceeding as before, and making

$$Y_4 = -\frac{dY_1}{dx}$$

and

$$M' = [8.12970 - 10] \frac{M^2 N w}{a \bar{\omega}}$$

we have

$$p = \frac{M' Y_4}{(1 + NY_1)^3} \quad (\text{B})$$

Equations (A) and (B) were first published in the JOURNAL U. S. ARTILLERY, Vol. VII, 1897, already referred to. They are equations (12) and (14) of that article. The function  $Y_4$  is deduced from  $Y_1$  by the relation

$$Y_4 = -\frac{Y_1^2}{n(1+x)^{\frac{n+1}{n}}}$$

*Maximum pressure.*—From (B) it is evident that  $p$  is a maximum when  $Y_4/(1 + NY_1)^3$  is a maximum. By applying the rule for maxima it will be found that when this occurs we have these relations

$$N = \frac{2Y_2 + (n-1)Y_2^2}{1 - (n+2)Y_2}$$

and

$$Y_2 = \frac{1}{2(n-1)} \left\{ \sqrt{[(n+2)N+2]^2 + 4(n-1)N} - [(n+2)N+2] \right\}$$

To determine the position of the point of maximum pressure we have from (24)

$$1+x = \frac{1}{(1-Y_2)^n}$$

and then

$$u = xz_0$$

If  $n = 6$  the above expression for  $Y_2$  gives

$$Y_2 = \frac{1}{5} \left\{ \sqrt{(4N+1)^2 + 5N} - (4N+1) \right\}$$

This is equation (32) of the JOURNAL article referred to above. If  $n = 3$  we have

$$Y_2 = \frac{1}{4} \left\{ \sqrt{(5N+2)^2 + 8N} - (5N+2) \right\} \quad (C)$$

*Formulas for velocity and pressure after the powder is all burned.*—The velocity of the projectile after the powder is consumed is given in all cases—no matter what the law of combustion may be or the shape of the grains—by (8), substituting  $\bar{\omega}$  for  $y$ . If  $V_1$  is the limiting velocity—that is, the theoretical velocity of the projectile after an infinite travel—we shall have from (8)

$$V_1^2 = \frac{\bar{v}^2}{\bar{Y}_2} = \frac{V^2}{Y_2} \quad (26)$$

Differentiating (26) and reducing, making

$$P' = \frac{12 w V_1^2}{2 \times 27.68 n g a \bar{\omega}} = [7.82867 - 10] \frac{w V_1^2}{n a \bar{\omega}}$$

we have

$$P = \frac{P'}{(1+x)^{\frac{n+1}{n}}} \quad (31)$$

*Expression for fraction of charge burned at any travel of the projectile.*—This is given in the most general manner by (15) in terms of the velocity of the projectile. The reduced equation takes different forms for different forms of grain. Thus, if  $\alpha = 1$  and  $\lambda$  and  $\mu$  are zero, (15) becomes

$$k = \frac{v}{\bar{v}} = \bar{Y}_1 Y_2$$

That is,  $k$  varies directly as the velocity and also as  $Y_2$ . If  $\mu$  is zero and  $\lambda$  negative (15) becomes

$$k = \frac{\alpha v}{\bar{v}} \left\{ 1 - \lambda \frac{v}{\bar{v}} \right\},$$

which reduces to [by (28') and (26)]

$$k = \frac{v^2}{V_1^2 Y_2} \quad (70)$$

the same expression in form as for Sarrau's law.

Finally we have from (8) and (26)

$$f = \frac{1}{144 \times 2g} \cdot \frac{\omega V_1^2}{n \bar{\omega}} = [6.03329 - 10] \frac{\omega V_1^2}{n \bar{\omega}}; \quad (64)$$

and from (14)

$$v_c = \frac{\pi g p_0}{4} \cdot \frac{l_0 d^2}{w \bar{v}} = [2.56963] \frac{l_0 d^2}{w \bar{v}} \quad (67)$$

It will be observed that the force factor is independent of the law of combustion and varies inversely as  $n$ ; and that  $v_c$  varies inversely as  $\bar{v}$  instead of  $\bar{X}_0$ .

It may be interesting to apply these formulas to one or two concrete cases, which will show clearly why the square root law of combustion was preferred to the law of the first power of the pressures. We will first take Sir Andrew Noble's firing with a charge of 20 lbs. of 0.3 inch cordite in an English 6-inch gun, the data for which have already been given in section I, of these "Notes." For cordite  $\alpha = 2$  and  $\lambda = -\frac{1}{2}$ ; and, in order to afford comparisons with calculations already made, we will take  $n = 3$  which makes  $Y_2 = X_2$ . Therefore (A) becomes, since  $Y_1$  is the reciprocal of  $Y_2$ ,

$$v = \frac{2 \bar{v}}{1 + X_2 Y_1} \quad (A')$$

For the pressure, while the powder is burning, we have

$$M' = [8.25464 - 10] \frac{\bar{X}_2 \bar{v}^2 \omega}{a \bar{\omega}}$$

and

$$p = \frac{M'}{X_2^2 (1 + x)^{\frac{1}{2}} (1 + X_2 Y_1)^3} \quad (B')$$

We have found for Sarrau's law for this example (Interior Ballistics, p. 124)  $x = 10.31918$ ,  $\bar{u} = 31.3$  ft.,  $\bar{v} = 2787.4$  f.s. and  $\log \bar{X}_2 = 9.74400 - 10$ . This value of  $\bar{v}$  agrees very closely with the velocity taken from Sir Andrew Noble's velocity curve for a travel of 31.3 ft., and will be considered correct. We will now deduce working formulas for velocity and pressure for this same example upon the hypothesis of a law of combustion directly proportional to the pressure, instead of to the square root of the pressure as before. And first we will assume that the grains are sufficiently dense, or, at least, sufficiently slow burning, to be consumed only after a travel of 31.3 ft. and to have a "force" ( $f$ ) sufficient to impart to the projectile for this travel, a velocity of 2787.4 f.s. On these suppositions (A') and (B')

extend about half way up the ogive. Fig. 3 shows the general form of head for an A.P. projectile embodying the above ideas.

## 2. THE BOURRELET

The rear part of the ogival head is turned down to a cylindrical surface, whose diameter is about 0.01 inch less than the caliber. This constitutes the front bearing surface of the projectile during its movement through the bore and is called the "bourrelet". Just before firing, the lowest element of the bourrelet is in contact with the lands of the rifling. When the piece is fired, the element of contact is continually changing until the bourrelet emerges from the bore. This results in a battering effect on the lands, mandreling them down in a manner that has misled some investigators of erosion. A wide

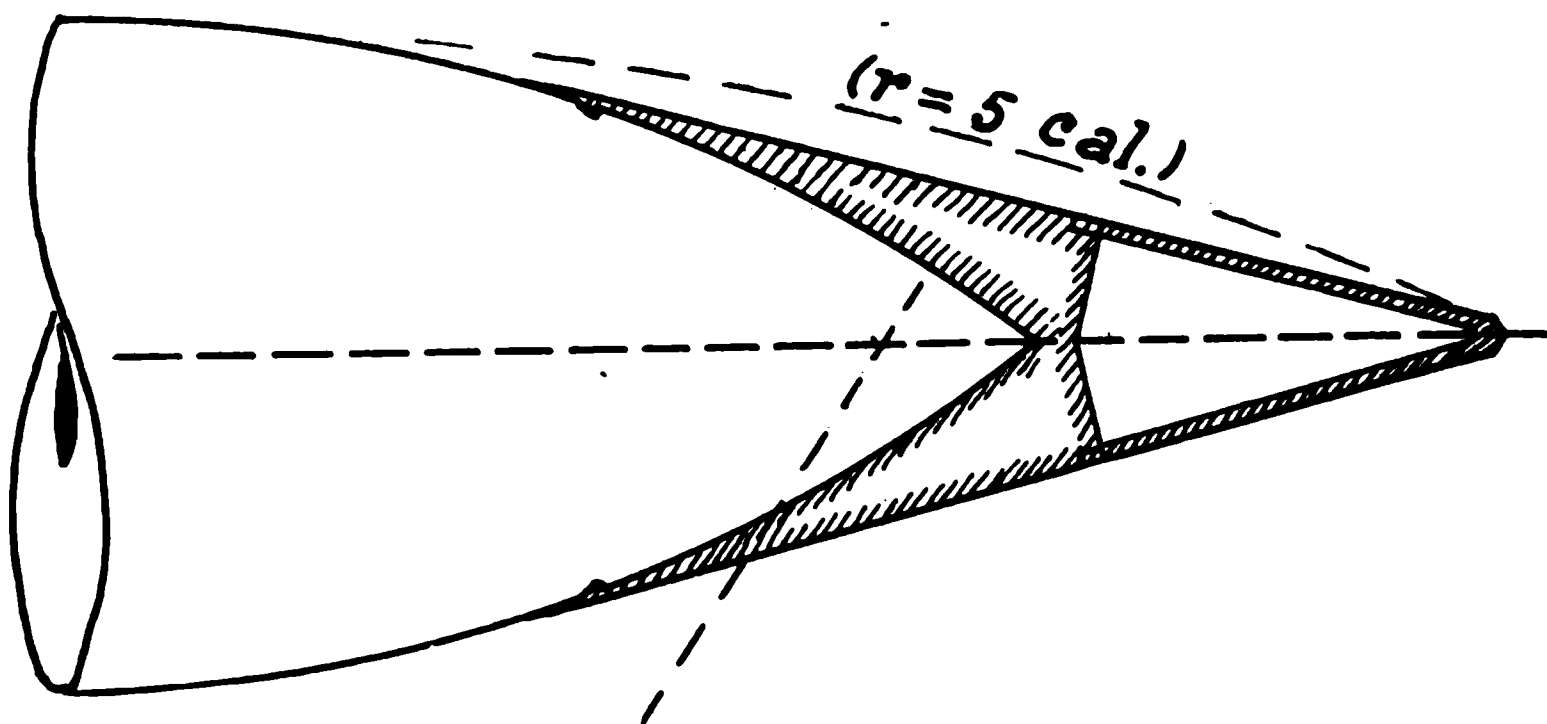


FIG. 3.

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bourrelet having a small clearance would cause less battering of the bore than would a narrow one having a larger clearance. The form and position of the rotating band also exercise a great effect on the amount of battering that a given projectile will produce. The width of bourrelet in most of our projectiles approximates 0.25 of the caliber. Using the slightly greater ogival radius advocated above would permit a corresponding widening of the bourrelet, resulting in a decreased battering of the bore.

## 3. THE BODY

The body of a projectile is the cylindrical part extending from the bourrelet to the rotating band. It is a few hundredths of an inch less in diameter than the bourrelet, for con-

We therefore have from (12), for Sebert and Hugoniot's law,

$$\frac{v'}{v''} = \frac{K''}{K'}$$

Since for  $\bar{v}$ ,  $K = 1$ , we also have for any fraction of charge burned,

$$v = K\bar{v}$$

The corresponding expressions for Sarrau's law are

$$\frac{X'_0}{X''_0} = \frac{K'}{K''}$$

and

$$X_0 = KX'_0$$

These last formulas can be verified by numbers taken from either of the accompanying tables of computed velocities. Thus, by Table I we have for Sebert and Hugoniot's law of combustion,

$$v = 2787.4 K.$$

By means of this formula, if  $k$  be taken for the argument, a table of velocities could easily be computed.

The velocities and pressures in the first part of Table I were computed by (D) and (E), and those in the second part by the formulas

$$v^2 = [6.54986] X_1 \{ 1 - [8.80138 - 10] X_0 \} \quad (G)$$

and

$$p = [4.80822] X_3 \{ 1 - [8.80138 - 10] X_4 \} \quad (H)$$

down to  $u = 31.3$  ft., where the powder was all consumed. Below this travel the formulas used were

$$V^2 = [7.14642] X_2 \quad (K)$$

and

$$P = \frac{[4.92766]}{(1+x)^{\frac{1}{2}}} \quad (L)$$

The pounds of powder burned in both parts of the table were computed by (F), employing the proper values of  $v$  in each case. It will be seen that the weights of powder burned by the two laws of combustion here considered, for any travel of the projectile, are proportional to the squares of the corresponding velocities—that is, to the work done.

If pressure curves be drawn to any suitable scale with the values of  $u$  in the second column for common abscissas, and for ordinates the pressures in columns four and seven, the areas under these curves from the origin to the muzzle will be equal,

that is, instead of running the ribs longitudinally, to give them a twist corresponding to the rifling. Experiment might show that this refinement would be worth the extra expense of manufacture.

#### 4. ROTATING BANDS

The rotating band is an annular ring cut from a copper tube, expanded by heat and shrunk into place near the base of the projectile in a groove, which is usually undercut. This groove is scored or knurled to prevent independent rotation of the band. The copper is forced into a tight fit by being run through a die, and is then turned to size and shape.

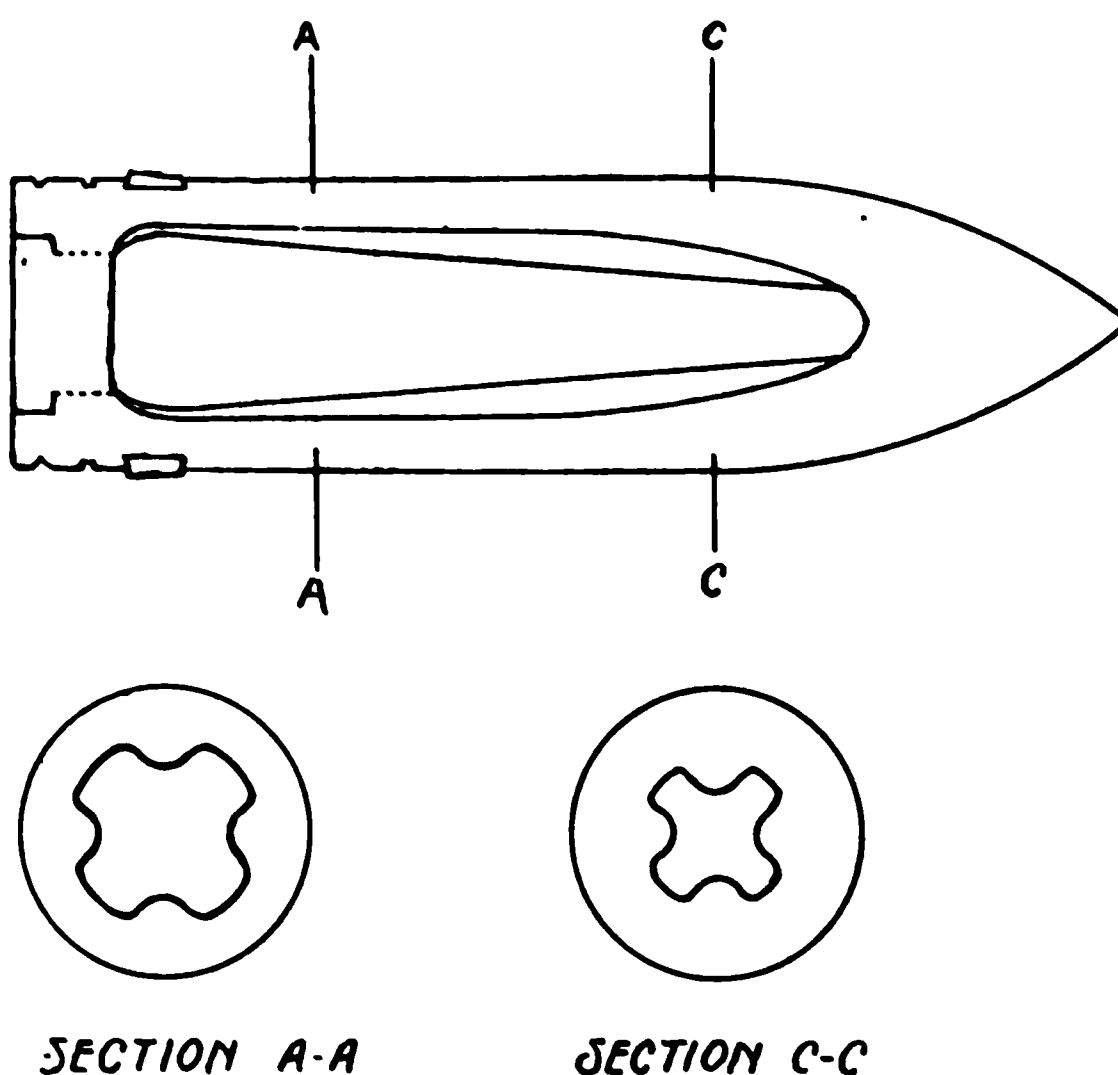


FIG. 4.

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The material used for bands has been the subject of countless experiments. The wide lead bands used many years ago by the French resulted in leading the bore. German silver and iron bands were tried but caused too much wear. Copper seems to be the survival of the fittest, although copper bands are sometimes stripped.

The exact position of the band is likewise of importance, as it has, among other things, an effect upon the range and accuracy of fire. Also, as the band groove is an unavoidable source of weakness, it should be placed where its weakening effect will be minimized, that is, well to the rear. A "closed-

By using the values of  $\bar{v}$  and  $N$  found above, equations (A') and (B') become

$$v = \frac{[2.11309]}{1 + [6.47770 - 10] Y_1} \quad (M)$$

and

$$p = \frac{[8.78615]}{X_2^2(1+x)^{\frac{1}{2}}(1+[6.47770-10] Y_1)^3} \quad (N)$$

After the charge is all burned (K) and (L) apply. The velocities and pressures in the first part of Table II were computed by (M), (N), (K), and (L), and those in the other part by (G), (H), (K), and (L).

In order to determine the position of maximum pressure, we substitute the value of  $N=0.0003004$  in (C) which gives for this travel of projectile,

$$X_2 = 0.00015.$$

Then by (24)

$$x = 0.00045$$

and

$$u = z_0 x = 0.01638 \text{ inches.}$$

Substituting these values of  $x$  and  $X_2$  in (M) and (N) we get at the point of maximum pressure,

$$v = 43.210 \text{ f.s.}$$

and

$$p = 100390 \text{ lbs. per in.}^2$$

These results are all shown in Table II, which is self explanatory.

For a second example illustrating the differences between the two laws of combustion we have been considering and showing why the law of the square root of the pressure was preferred to that of the first power, we will take the data given on page 102, Interior Ballistics, for an 8-inch gun using single perforated grains of sufficient length to make the grain characteristics  $\lambda$  and  $\mu$  zero and  $\alpha$  unity. The value of  $v_c$  for these grains was found to be 0.13614 inches per second. (Interior Ballistics, p. 105.) Substituting this value of  $v_c$  in (67) we get

$$v = 40.170 \text{ f.s.}$$

Equation (26) may be written in this case,

$$X_2 = \frac{X_{2m} \bar{v}^2}{V_m^2} = 0.00016949,$$

by using numbers given on page 103, Interior Ballistics.

Therefore from (24)

$$\bar{x} = 0.00050865$$

and then, since  $z_0 = 44.548$  inches,

$$\bar{u} = z_0 \bar{x} = 0.02266 \text{ inches,}$$

which is the travel of the projectile when the charge is all consumed.

The formulas for velocity and pressure while the charge is burning are now found to be by, (7') and (8'),

$$v = [5.37476] X_2$$

and

$$p = \frac{[8.99660] X_2}{(1+x)^{\frac{1}{2}}} = \frac{[3.62184] v}{(1+x)^{\frac{1}{2}}} = [9.47372] Y_3$$

After the charge is consumed these formulas become, by (26),

$$V^2 = [6.97866] X_2$$

and

$$P = \frac{[4.92471]}{(1+x)^{\frac{1}{2}}}$$

The expression for powder burned for any travel of projectile is

$$y = \frac{\dot{w} X_2}{X_2} = [5.66295] X_2$$

The first part of Table III was computed by these formulas and the second part by those given in Interior Ballistics, p. 103, for Sarrau's law of combustion, namely:—

$$v^2 = [6.20718] X_1$$

$$p = [4.63036] X_3$$

$$y = \frac{\dot{w} X_0}{X_0} = [1.12061] X_0$$

It will be seen that, properly speaking, there is no maximum pressure in this case (for the law of the first power of the pressures), as the charge is consumed before there could be one. The pressure drops from 168050 lbs. at a travel of 0''.023 to 84016 lbs. at a travel of 0''.027, owing to the great vanishing surface of the grains. In order that there may be a maximum pressure the grains must be sufficiently slow burning to last beyond  $x = 61/64$ , or in this example, for a travel greater than 42.46 inches. Suppose we make

$$\bar{v} = 2040 \text{ f.s.}$$



and assume that the charge is all consumed at the muzzle. From (67) we find  $v_c=0.00268$  inches per second. That is, in order to fulfill these conditions the grains must burn so slowly as to require nearly half a minute to burn up in open air. With the above value of  $\bar{v}$  and  $\log \bar{X}_2=9.64060-10$  (muzzle value), we find

$$\log M=3.66903$$

and

$$\log M'=6.06226$$

Therefore  $p_{\max.}=0.027307\ M'=31516$  lbs. per in.<sup>2</sup>

This is not far from the observed crusher gauge pressure, but it depends upon an abnormal slowness of burning of the grains.

TABLE I.

Computed velocities and pressures in a 6-inch gun fired with a charge of 20 lbs. of 0.3 inch cordite, and a 100 pound projectile, for different travels of projectile from seat to muzzle.

<i>x</i>	<i>u</i> feet	Sebert and Hugoniot's law of combustion			Sarrau's law of combustion		
		Velocity f.s.	Pressure lbs. per sq. in.	Powder burned lbs.	Velocity f.s.	Pressure lbs. per sq. in.	Powder burned lbs.
0.001	0.00303	3.35	405	0.048	11.34	3485	0.551
0.010	0.03033	33.09	3920	0.472	63.05	10673	1.714
0.0264	0.08	86	9727	1.208	129	16657	2.814
0.0923	0.28	277	27018	3.778	316	27508	4.916
0.1582	0.48	442	37442	5.843	458	31973	6.266
0.2901	0.88	714	46929	8.929	681	36414	8.132
0.4220	1.28	928	48972	11.098	856	37291	9.446
0.6594	2	1220	46031	13.674	1102	36076	11.162
1.3187	4	1706	32522	16.988	1551	29274	14.014
2.6375	8	2156	17608	18.974	2032	19129	16.854
5.2750	16	2521	7940	19.817	2474	9712	19.086
7.2531	22	2657	5301	19.956	2642	6316	19.726
9.2312	28	2749	3864	19.996	2747	4188	19.974
10.3192	31.3	2787.4	3331	20	2787.4	3331	20
11.8687	36	2834	2807	—	2834	2807	—
14.5061	44	2897	2189	—	2897	2189	—
15.3640	46.6	2914	2038	—	2914	2038	—
	Muzzle						

excessive windage. Surely something can be done to improve the state of affairs shown in this picture.

As regards possible improvements in our bands, it is understood that a wide band has been adopted for use in our service, but its measurements are unknown to the writer. Now, the narrow bands seldom strip, and their width measures but 0.125 caliber. This narrow band causes comparatively little loss of energy in the bore. The wider the band we use the more energy of the powder do we lose in making it overcome friction and perform the necessary deformation of the band. Also, as our guns are rifled with an increasing twist, the junk rings are sheared circumferentially, thus adding to the loss of energy. Nobel deduced a value of over 4.7 per cent loss of energy when using a band 0.4 cal. wide and uniformly increasing twist ending with one turn in 35 calibers.

Another fact must be considered in connection with wide bands for our guns, and that is the steepness and brevity of our centering slopes. In the 12-inch B.L.R., model 1900, this slope is but 2.85 inches long, while our narrow band is 1.5 inches wide. Therefore we see that it is impracticable to increase the width of the band to any great extent without changing in some degree the design thereof. The wide band, needing a wide groove in the projectile, has the further disadvantage of increasing to a certain extent the weakening influence of this groove.

With all its disadvantages it is believed that the principle of the wide band is sound. There is little doubt that it decreases erosion, that it is better for use in guns already eroded and is less apt to strip. The writer is personally in favor of widening the bands (especially in the case of the larger calibers) to as near one third of the caliber as practicable. This need not increase the loss of energy in the bore to an alarming extent, provided we design the wide band so that the proportion of the areas of cross-section of the cannellures to that of the junk rings (*i.e.*, the copper sheared by the rifling) be considerably increased. The area of cross-section of the effective copper is approximately sufficient, even now, to prevent stripping; therefore there would be little advantage in doubling this area, if we decided to double the width of our band.

As regards the cannellures, our text books inform us that they are for the purpose of reducing the work performed by forcing the projectile through the bore, and to provide room for the copper displaced by the rifling. No mention is ordi-

TABLE IV.

Logarithms of the  $X$  functions from  $x = 0.0001$  to  $x = 0.001$ .

$x$	$\log X_0$	$\log X_1$	$\log X_2$	$\log X_3$	$\log X_4$
0.0001	8.53959	4.06244	5.52285	8.23851	8.66453
0.0002	8.69009	4.51394	5.82385	8.38896	8.81504
0.0003	8.77815	4.77805	5.99991	8.47695	8.90309
0.0004	8.84060	4.96542	6.12482	8.53937	8.96555
0.0005	8.88905	5.11075	6.22170	8.58776	9.01401
0.0006	8.92864	5.22949	6.30086	8.62730	9.05360
0.0007	8.96212	5.32990	6.36777	8.66073	9.08708
0.0008	8.99110	5.41683	6.42574	8.68966	9.11606
0.0009	9.01667	5.49353	6.47686	8.71517	9.14163
0.0010	9.03954	5.56213	6.52259	8.73800	9.16452

# IMPROVISED DEVICES FOR THE PLOTTING ROOM OF A PRIMARY GUN BATTERY

BY CAPTAIN FREDERICK L. DENGLER, COAST ARTILLERY CORPS

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The following described devices and methods are in use in the plotting room of a primary gun battery, and a brief description of their essentials may be of interest to the artillery service. The Range Corrector and the Adjustable Deflection Scale were made in a local machine shop from scrap material, and the plotting board grips were furnished by the Engineer Department, after designs by the author.

## ADJUSTABLE DEFLECTION SCALE

The arbitrary scale for the deflection board furnished by the Ordnance Department cannot be fastened in position on the board when its use is desired and is, therefore, liable to become shifted by the computer incident to other operations about the board. It does not, when in position, cover the present deflection scale, which tends to confuse the computer since he has in view two similarly graduated scales, one of which only is to be finally read.

To overcome these defects and to provide the range officer with assurance that the arbitrary correction ordered, is actually being employed, an adjustable deflection scale has been designed. The device is so simple that no description is here given, Fig. 1 being considered sufficient for this purpose. The new scale is installed on the deflection board by removing the fixed deflection scale, and setting in proper position the lock and guide screw blocks. No material alteration of the board is necessary in making the installation; in fact, the only change made consists in boring in the wooden base shallow holes for the reception of the blocks above referred to.

*To use the new scale for reading uncorrected deflection.*—Adjust the scale to the normal position by shifting, when necessary, until its 3° graduation mark is in prolongation of the 15° lines of the Azimuth Correction and Travel scales. Reset the clamp screw, and proceed as now prescribed.

*To use the new scale for applying a deflection correction.*—Assume that the shot strike has been observed by the B.C. instrument or a telescopic sight reading from the normal, as  $3.20^\circ$ . Set the bevel edge of the T-square on the  $15^\circ$  lines of the Azimuth Correction and Travel scales, release the clamp screw and shift the adjustable scale until  $3.20^\circ$  on it is read under the bevel edge of the T-square; reset the clamp screw. It is evident that all deflection reference numbers now read from the scale will have been increased by  $0.20^\circ$ , which will correct for the observed error.

The length of the adjustment slots of the scale described is such that a correction of  $0.50^\circ$  may be made on either side of the normal. This was assumed to be sufficient for all practical purposes.

#### RANGE CORRECTOR

This device is used as a part of an emergency system in which a Barr and Stroud range finder is employed. It consists of a brass block slotted to function on the rib of the gun

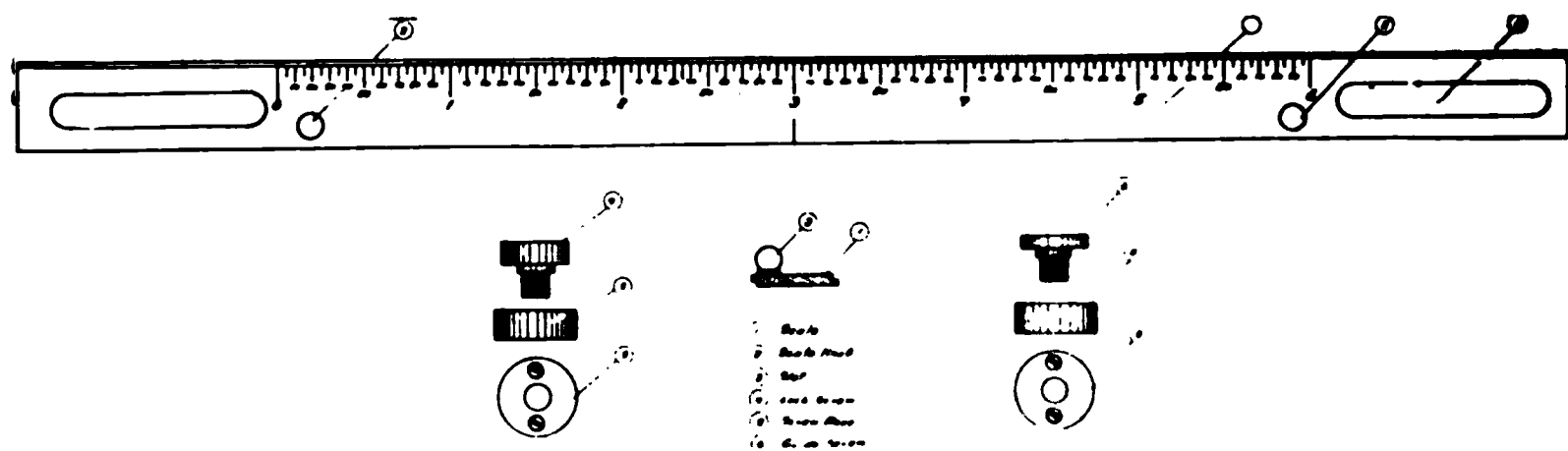


FIG. 1.

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arm of the plotting board. It is provided with a pointer fixed opposite the normal of the correction scale, and extending to the graduated portion of the gun arm. There is cut on the top surface of the block a correction scale graduated to 10 yards on a scale of 300 yards = 1 inch, and reading from 1000 to 3000, with 2000 as the normal. The top surface of the block is provided with an undercut groove in which functions a slide fitted with a lock screw and a pointer. This pointer extends from the correction scale of the block, over the block to the graduated portion of the gun arm, and is so constructed as to clear the fixed pointer of the block when moved on either side of the normal.

*To use the corrector.*—When the emergency condition is announced, the plotter puts on the head set of the telephone

to the emergency range finder, slips the corrector on the gun arm, and calls off actual ranges to the target as announced from the range finder until the range computer calls out the range correction reference number. The plotter then sets this number on the slide scale by the slide pointer, locks the slide, shifts the block until the actual range to the target is read on the gun arm scale opposite the block pointer; the corrected range to the target is then read on the gun arm scale opposite the slide pointer. Details of the device are shown in Fig. 2.

The angular data necessary in the determination of wind effect reference numbers, and the travel of target during the

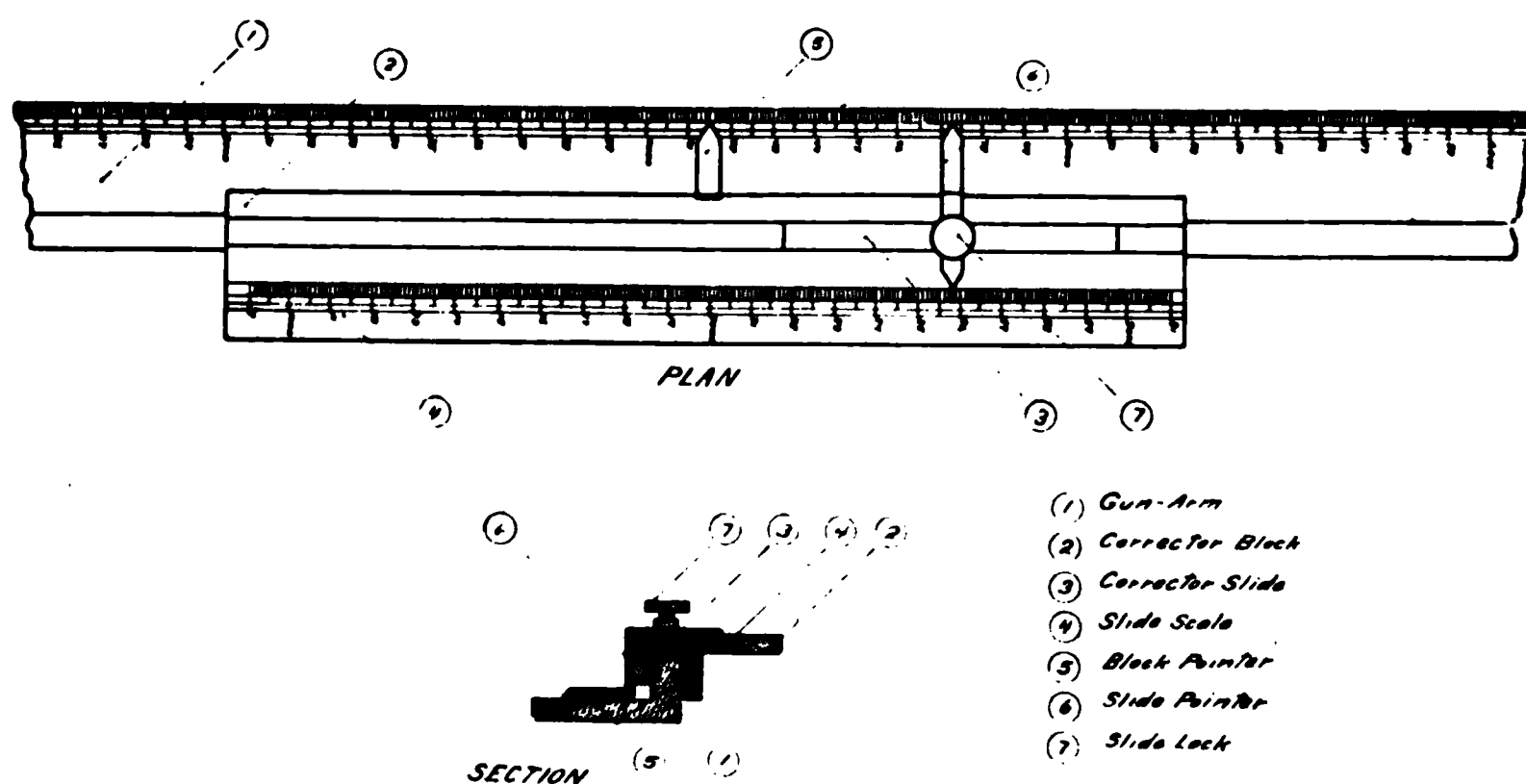


FIG. 2.

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observing interval used in computing deflection, are supplied by the B. C. observer with the B. C. instrument or telescopic sight fixed to the old type azimuth instrument as follows:

1. Reads and reports azimuth of target to nearest  $5^\circ$  when first assigned, and thereafter only when the change in azimuth differs from that last reported by approximately  $20^\circ$ .

2. Reads and reports angular travel of target during first two observing intervals following assignment. For this purpose the deflection scale of the instrument is employed, the origin of each reading being  $3^\circ$ . This operation is repeated only upon resumption of firing after an interruption, and when the target turns or otherwise materially alters its course.

To admit of the direct application on the deflection board of travel reference numbers as read from the deflection scale of the B. C. instrument, a new platen scale has been made for the deflection board. It is graduated on the basis of the 30 sec-

ond observing interval, with  $0^{\circ}$  on the right,  $6^{\circ}$  on the left, and  $3^{\circ}$  as normal. No illustration of this device is considered necessary.

#### GRIPS FOR THE PLOTTING BOARD

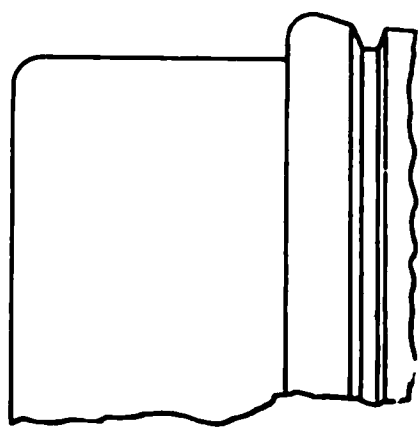
With the plotting room located in, or immediately in rear of the battery, a frequent source of trouble during service practice occurs when the plotting board jumps or shifts after each shot.

FIG. 3.

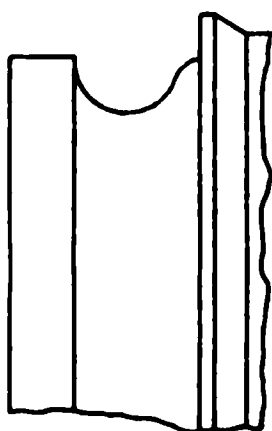
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This has been overcome by attaching two pairs of grips to the groove in the plotting board supports. These grips are then fastened to the floor of the plotting room by means of stay rods which lead off at an angle of approximately  $45^{\circ}$ , and are made adjustable by means of turnbuckles. They are not attached to the board or tightened up until immediately before firing is to take place. A view of a plotting board with grips attached is shown in Fig. 3.

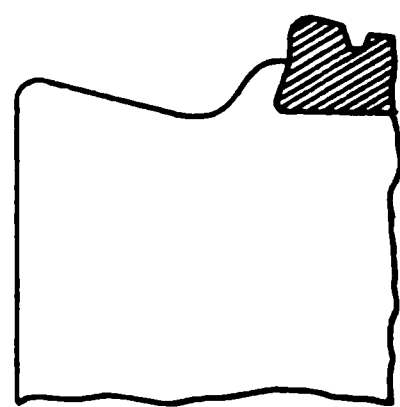
should be little if any difficulty experienced in ramming the projectile to a firm and proper seat, with about 2.5 inches of the band within the forcing cone and the last four junk rings in contact with the centering slope. It rarely happens that a ramming detail does not use force more than sufficient to overcome the slight resistance offered to the rifling by the extension to the band. As shown above, this part of the band with its seven cannellures being within the forcing cone cannot but greatly increase the obturating effect of the band, and it would also tend to prevent the projectile's being jammed back from its seat. In this proposed band there is considerably more effective copper than in the present band, but a greater proportion of the area of cross-section is allotted to the cannellures. Of the conical junk rings, all except the last are a trifle less in exterior diameter than in the present type, thus tending to



ARMY



NAVY



FIRTH-RENDABLE

FIG. 10.

1263

minimize the deposit of copper along the bore. The position of the band as shown in Fig. 9 is to be considered as only tentative, depending upon experiment for its final position. It should be placed as far to the rear as may be found permissible, for reasons which will be discussed later. It is hoped that the adaptation of the Butler lip shown at the rear of the band might have some effect in decreasing windage, but test alone can settle the point.

## 5. THE BASE

Some of the various shapes given to the exterior surface of the projectile in rear of the rotating band are shown in Fig. 10. In actual firings against armor plate it was found that sometimes the pressure of the rotating band would cause the whole base of the projectile to tear off. Hence the adoption of a groove behind the rotating band, leaving just enough metal in



division being  $\frac{1}{2}$  inch. The inner end of the groove ends in a concentric circle in order to prevent damage in case the gun is depressed to below 3000 yards. A pin located in the center of the disk and riding in a hole drilled in the vertical rod, holds the rod rigid and in place. This device was used in two service practices, check marks being made at each round fired in order afterwards to verify the setting. An extra man was stationed at the old range scale to verify the ranges and to prevent glaring errors. No errors were made in laying during either of the two practices, though the new disks were completed and in use just a few hours before the first practice.

FIG. 1.

1271

The proposed range disk as fastened does not permit the use of the handle which is ordinarily used when it is desired to make a material change in the elevation, say several thousand yards. In all changes of elevation with this disk the handles radiating from the circumference must be used. If this is considered objectionable, the disk can be mounted on the elevating shaft between the hand wheel and the chassis.

Under the amended drill regulations the gun commander is required to verify the setting of the range disk before the gun is fired. It is believed that few practices are held in which errors are not made in the setting of the disks, and errors as

is easy to see that the closed-in base is better adapted to withstand the shock of discharge, as it involves the principle of the arch instead of that of the beam. This would finally result in one of three things:

- a. For equal strength of base, a larger cavity;
  - b. For equal strength of base, stronger projectile at other points;
  - c. For equal thickness of base, greater factor of safety.
- There being but one threaded surface instead of the usual two, the powder gases would be less liable to force their way into the cavity and the use of our troublesome base covers might

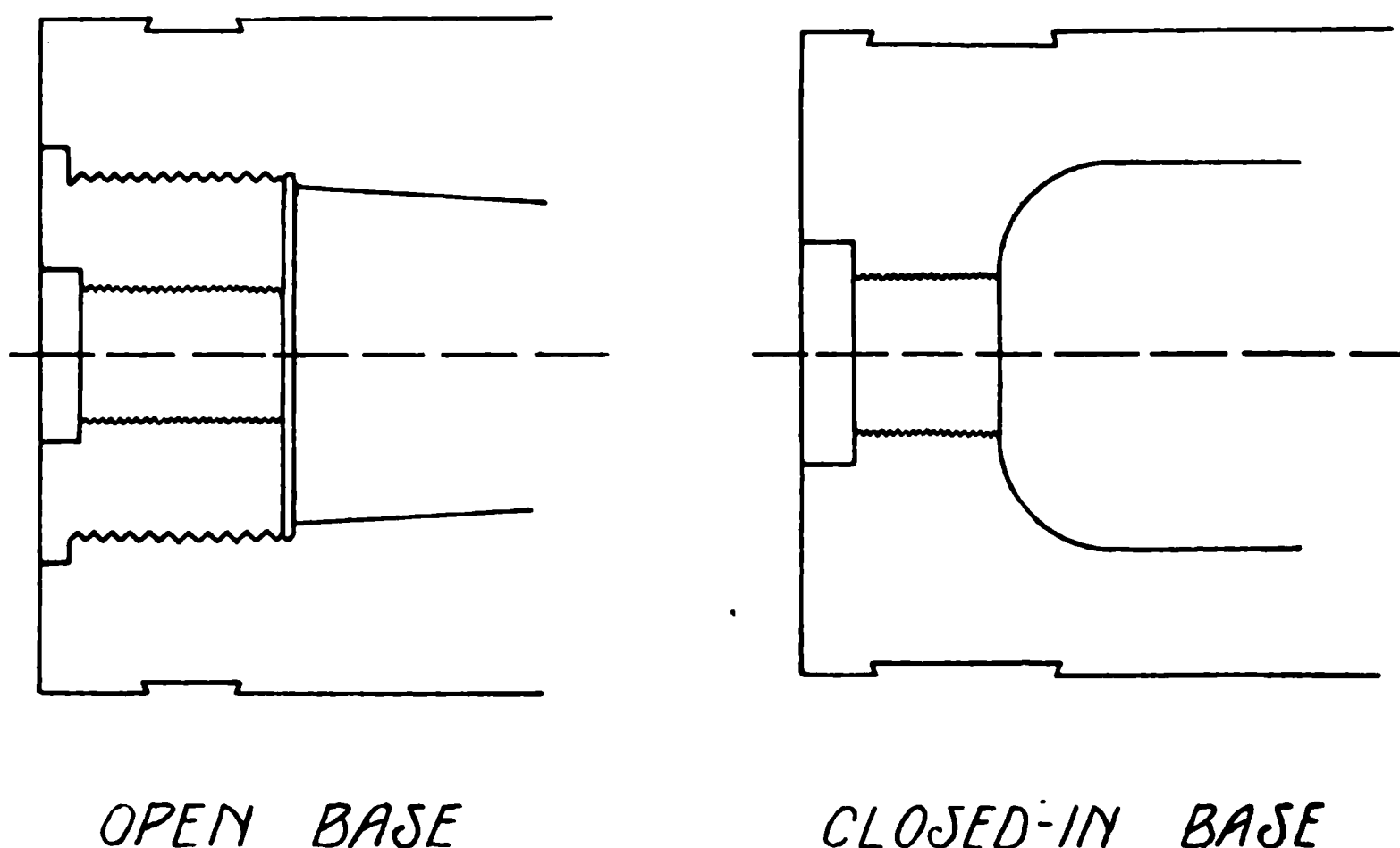


FIG. 11.

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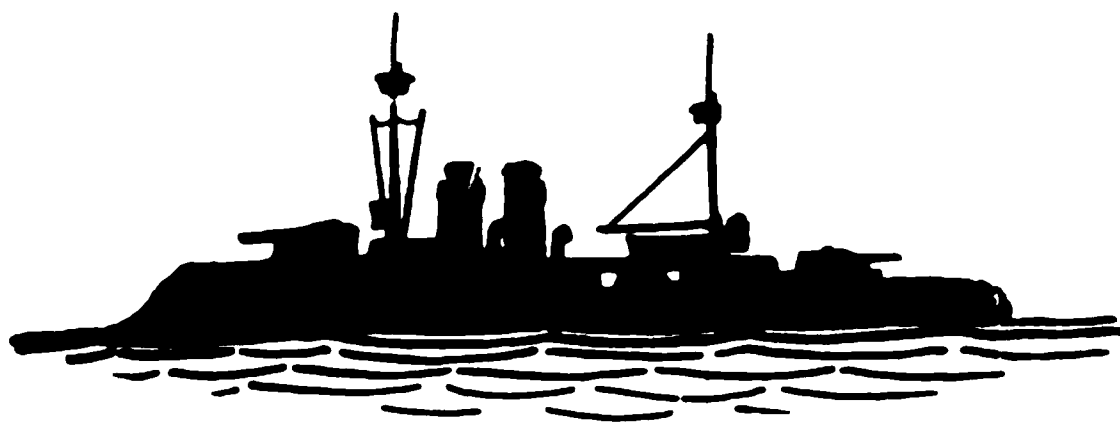
be abolished. This may seem to be a small item, but in time of war it would mean one less thing to be considered. It is probable that the cost of forming this base would not exceed that of supplying the base plugs that are now necessary. The only disadvantage in using a closed-in base lies in the *possibility* that it would render shell filling more difficult, and even if this were a fact, it is not of sufficient importance to outweigh the many good points of such a base. This form of base has been adopted for our 3-inch projectiles for some years, and should be continued for obvious reasons.

#### 6. SHELL TRACERS

In time of war we should be able to distinguish the **splash** of one gun or battery from that of another. Otherwise, **with**

from that distance. Not only the gun commander sees the setting, but several members of the gun and telephone crews see it as well, and all can (and many do) check it with the range on the black board or range indicator. In this way the possibility of laying the gun incorrectly is reduced to a minimum.

In Fig. 2 is shown a range indicator used in two service practices which gave satisfactory results. The four separate and adjacent cloth rolls on which the figures are painted are each operated by a crank handle. In the two-gun 6-inch D.C. battery where this was used, a temporary B. C. station was rigged up in rear of, on the windward side, and about fifteen feet higher than the guns. In this station were the indicator shown in the figure operated by four men, an observation telescope, and a telephone to plotting room. A place was also arranged for the self contained short horizontal base range finder. Ranges which came from the plotting room were chalked on a small blackboard and set on the range indicator. The battery commander observing with his telescope could apply any range correction which he considered proper before setting it on the indicator. A blackboard was fastened to each gun carriage near the elevating hand wheel and the ranges shown on the indicator were called out and chalked thereon by two men.



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The rounded shape of the tracer case need not interfere with the proper ramming of the projectile, as the rammer head could easily be altered if found necessary. The shock of ramming would be less than the shock of discharge, so no harm to the tracer need be anticipated from that quarter.

Experiment should show the best method of attaching the case to the projectile, that shown in Fig. 12 is but a suggestion. If we are to continue filling and fuzeing our projectiles at posts, it is necessary that this method of attachment be of such a nature that it, too, can be performed expeditiously by post labor. The method shown in Fig. 12 involves the use of a forged steel ring permanently fastened to the tracer case, with a female thread (left handed) for attachment to the projectile. The illuminating compound, if furnished in a compressed cake, could be inserted before attachment to the projectile; or, if furnished in a powder form, could be inserted through the tracer fuze hole after attachment. As shown in Fig. 9, a lead base cover could be used as at present, the tracer case clamping it firmly to the base without additional trouble.

Even allowing for very heavy walls, it is seen that this tracer case has a comparatively great capacity, thus allowing for the large charge of the illuminating composition which would probably be necessary, considering its requirements of day and night action. It might even be large enough to warrant its use with mortar projectiles, should such use be found desirable.

Of course, if such a tracer were to be adopted for use in connection with our war projectiles it is evident that it must also be supplied for target practice projectiles, in order to obtain the same ballistic results and to permit officers and men to become thoroughly familiar with its action.

## II.

### SPECIAL TYPES OF PROJECTILES

#### A. PROJECTILES FOR TARGET PRACTICE

##### 1. *Subcaliber Practice*

Efficient projectiles for this purpose should, of course, be reasonably uniform in weight, shape, etc., in order to give the desired results. There seems to be little difficulty in securing such uniformity. In addition, however, it is important that such projectiles give a splash that is reasonably sure to be visi-

FIG. 3.

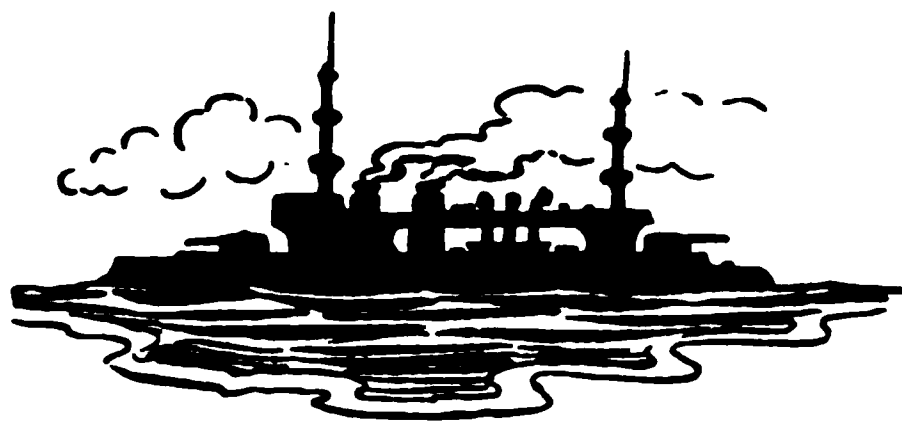
1275

FIG. 4.

1276

tion, allow time for tripping, etc., traverse the gun and fire the Marlin, thus simulating the conditions, as nearly as possible, of service practice.

This scheme aroused great interest in the company. The gun-pointers were practiced every day after the regular drill period, and sufficient progress was made to warrant the adoption of the scheme. Four hits out of eight shots at an average range of about 7500 yards were made at the battery service practice for 1912.



# AN IMPROVISED SEARCHLIGHT CONTROL

BY MASTER ELECTRICIAN A. C. KERR, COAST ARTILLERY CORPS

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It was desired to place the controller of a 36-inch portable light in the Battle Commander's Station, 5800 feet from the place where the light was to be set up for operation. There was but 1000 feet of controller cable on hand; however, a 19 gauge paper telephone cable ran from "C" Station to a station about three hundred feet from the light. It was decided to stretch the controller cable from this station to the light and improvise a system of control that could be worked through the telephone cable, using the 30 volt supply for the Fire Control system as the actuating power. The scheme finally adopted is as follows (see diagram).

The controller proper consists of two small rocker arms, one for the vertical motions, one for the horizontal motions, and a small push button. The rocker arms close contacts which actuate polarized relays in the apparatus at the light; the push button actuates a pony relay, also at the light. Thirty volts from the F. C. system is used in the controller.

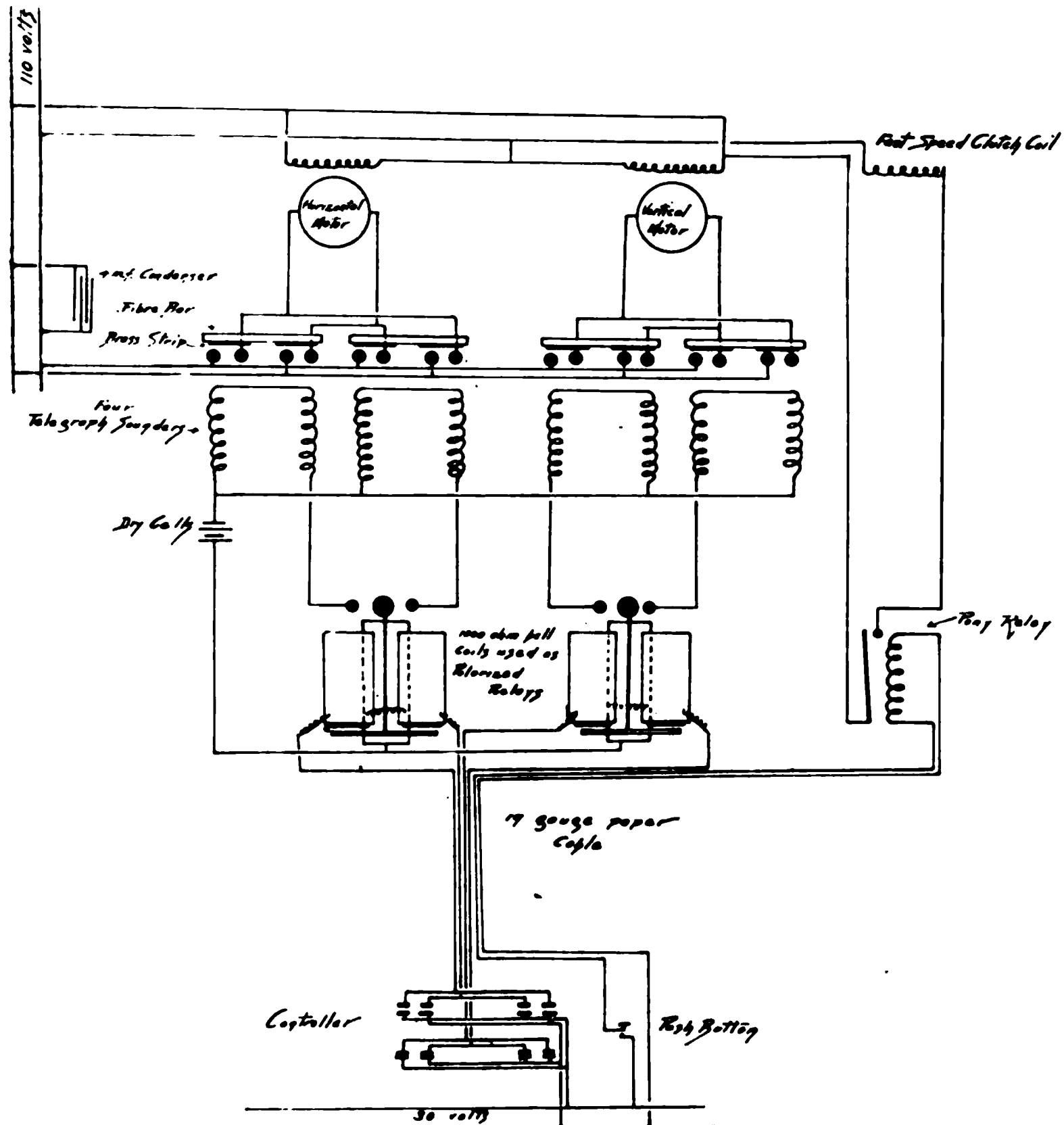
The control apparatus at the light consists of two 1000-ohm bell coils used as polarized relays, a pony relay, and four telegraph sounders. When the bell coils are energized the hammer makes contact on a small carbon block, closing a local circuit for a telegraph sounder. A set of bell coils is used for the horizontal and one for the vertical motions.

Screwed to the hammer bars of the sounders are short fibre bars, on the under side of which, at each end, are short brass strips. When the armature of the sounder pulls down, these brass strips close the circuits of the armature for the control motors. The contacts are made of arc light carbons turned down and working in a short piece of  $\frac{1}{4}$ -inch brass pipe, similar to a small fan motor brush. A spring is below each carbon brush and the brushes are mounted in wooden strips fastened beneath the fibre bars.

The pony relay controls the fast speed clutch coil. Normally the slow speed gearing is engaged, giving a speed



sufficient to follow a target in the beam; but when a considerable arc is to be traversed rapidly by the light, the push button at the controller is actuated, thus throwing in the high speed gearing and giving the maximum speed. The portable light in question has but one clutch coil, but the same scheme could be



SEARCHLIGHT CONTROLLER

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Imvised by Master Electrician C. Kerr, C.A.C., and Electrician Sergeant E. C. Backhaus, C.A.C.

used on any G. E. light with two clutch coils by placing a back contact on the armature of the pony relay to close the circuit of the slow speed coil.

The bell coils give positive action on 30 volts through a line resistance of approximately 100 ohms, the controller being, as noted above, over a mile from the light.

The controller is very small, being about four inches square. The apparatus at the light is mounted in a small watertight box. All the material was on hand in the storeroom of the artillery engineer, and in its present condition the controller gives excellent service.

It might be noted that the sounders, which are 4-ohm instruments, were first tried connected directly to the line; but the line resistance was too great for satisfactory operation, so the bell coils were cut-in to act as polarized relays. If main line sounders were available, it would not be necessary to use the bell coils.

# COMPANY ADMINISTRATION

BY CAPTAIN ADNA G. CLARKE, COAST ARTILLERY CORPS

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Having signed morning reports almost continuously for the last twelve years, and having been requested to relate his experience as a company commander, the writer submits the following, most of which he has copied from efficient company commanders.

The first essential for a company commander is personal knowledge of his men; and this knowledge being acquired only by contact with them, no officer need fear that he can spend too much time with his men: he need only be careful that his own bearing and conduct be such that familiarity shall not breed contempt.

In making a soldier, a great deal depends upon the instruction imparted and the impression given during the recruit period. This also is the time that the company commander should be studying the habits, disposition, temperament, and capability of the future member of his company.

It is a good practice within a day or two after the recruit joins the company to send for him and question him at considerable length, and to attempt to instill in his mind a pride in himself, in the service generally, and in his own company particularly. Ask him what schooling he has had, what trade, occupation or profession he has worked at on the outside; what sports he has taken part in, if he can play baseball, football, basket-ball, or what he can do on the field and track; how he came to enlist; his impressions of army life before he enlisted; and if those impressions have been changed since. Show him the company discipline book, emphasizing the fact that he starts with a clean page.

Tell him of the points of excellence of the company to which he has been assigned, as well as of the opportunities afforded by his branch of the service. Acquaint him with the best the company has done in artillery target practice, or in qualifying gunners, or in small arms target practice, or on the

athletic field, according to the circumstances of the case. Give him a feeling of proprietorship in the company's property—its funds, its cows, its hogs, its chickens, its boats—in anything which local conditions may have made it advantageous for the company to acquire.

Then on making the recruit feel that membership in the company is an honor to him, impress upon him also that he has a contribution to make for the company's welfare and honor: that you are going to depend upon him to assist you in maintaining the company's position of excellence, or even in advancing it; that while every man likes to belong to the best company, he cannot expect his to be the best unless he does his part to make it so.

A word in explanation of military subordination is now desirable, showing the recruit the necessity for it, and making clear to him that its quality is the same throughout all grades, the form, or expression, only differing. Tell him that the salute is not a badge of servitude, but a mutual exchange of a courtesy and mark of respect on the part of officer and man.

A few remarks on the correct view to take of the various kinds of fatigue duty are helpful to the young soldier, and may do much to prevent his starting wrong, and to insure his starting right. Words may, in a sense, be cheap; but they are nevertheless valuable in making a first impression.

In the matter of company discipline, it is the writer's experience that more men respond to an appeal to their pride than to a fear of punishment. A good way to reach this element of pride is by a system that classifies men according to their conduct, the first, second, and third classes, representing, generally, excellent, very good, and good, as those terms are used upon a soldier's discharge certificate. When the system is instituted, all men are placed in what is called the "original first class". When a man commits some reasonably serious offense, such as absence without leave for twenty-four hours, drunk and disorderly in post, or failure to act promptly when spoken to by a non-commissioned officer, he is reduced to second class. If then his conduct is perfect for thirty days, he is restored to first class not to the "original first class", of course, for a man who is once taken off the original first class list cannot get back to it during that enlistment. If, while in the second class, he again commits himself he is reduced to third class. Third class men can, by excellent conduct for thirty days, advance to second class, and in a similar manner,

to first class. Reduction to second class carries with it five extra tours as cook's police and restriction to the post for thirty days; while reduction to third class results in five additional tours as cook's police and restriction for sixty days.

The summary court is only resorted to for the correction of the more serious of the minor offenses. Conviction by summary court carries with it reduction to third class, including restriction, but not the extra tours as cook's police. This last provision is found necessary, as otherwise some men would prefer a summary court trial to a reduction in class.

Every possible privilege is granted men in the first class. Where practicable to do so, they are granted "permanent passes" signed by the company commander and the adjutant, authorizing them to be absent from the post at any time when not required for duty. When a man is reduced, his pass is taken up and retained in the company office. A roster of the company, showing the class to which each man belongs, is posted at all times on the company bulletin board.

Furloughs, unless for exceptional reasons, are approved only for men in the first class.

It is the writer's experience, after four year's faithful trial in two organizations, that this system of classification of men according to conduct is the most excellent method of administering company discipline.

Another device that tends to make the administration of the company more efficient, is a regulation to the effect that men asking for passes after the prescribed hour shall be required to do two extra tours as cook's police, not as a punishment, but merely as an earnest that the reason for asking for the pass after the prescribed time was *bona fide*. If the pass under exceptional circumstances is not worth that amount of extra effort on the part of the applicant, it should not be granted. A hard and fast rule that passes will not be granted after a certain fixed hour, usually twenty-four hours before they are desired, sometimes works an unnecessary hardship; whereas, under the above regulation, the question of importance of the pass is put up to the man himself, and very few, and those only such as should be granted, are asked for. A similar plan works well in the application for extension of passes, especially where the practice of calling up on the telephone obtains.

For minor offenses which do not merit reduction to a lower class, extra tours as cook's police are found sufficient, and they are not made of record in the company discipline book.

One of the most difficult duties an officer has to perform is the determination of the "character" to be given a man upon his discharge certificate. While conforming to the customary standard, the writer has always made use of the blank space for remarks upon the back of the discharge certificate to enter any facts he thinks will benefit the holder, either in a future enlistment or in civil life. For instance: "This man is an excellent range computer;" "This corporal has twice during this enlistment made 100 per cent at target practice as gun pointer;" "This sergeant is an efficient company clerk;" "This sergeant is a reliable and competent mess sergeant." Upon the discharge certificate of men who are just completing their first enlistment and who believe that they will not again enlist, he usually places some truthful remark that may assist them in civil life. Few persons outside the military service have any knowledge of the service distinctions as to "character"; but a remark to the effect that, "This man is thoroughly sober, reliable and trustworthy", is understood. The writer frequently receives letters from men he has discharged stating that the remarks placed upon their discharge certificates have secured them either promotion or selection in the service, or good jobs on the outside.

# COAST DEFENSE IN THE CIVIL WAR\*

## ISLAND NUMBER TEN†

BY 1ST LIEUT. WALTER J. BUTTGENBACH, COAST ARTILLERY CORPS

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### GENERAL SITUATION

After Forts Henry and Donelson had fallen, General Halleck was of the opinion that the movement down the Mississippi should be continued, and that New Madrid, where a Confederate force was, should be the next objective.

### SPECIAL SITUATION

New Madrid was evacuated by the Confederates after a short fight; and Fort Pillow was selected as the next place for a stand against the Federals, while Island Number Ten was to be an advanced work to stop the movement of the Federals for the time being.

General Pope, after getting possession of New Madrid, advanced down the right bank of the Mississippi to a point about opposite Tiptonville. In connection with these operations there was a combined army and navy attack on Island Number Ten, which we are now to consider.

### OPPOSING FORCES

The fortifications about Island Number Ten consisted of works on the island and works opposite it on the Tennessee shore.

On the island earth works had been built commencing at the extreme southeast point, where was Belmont Battery, and extending about 1300 yards along the east front. The batteries, numbered from right to left, were as follows:

\* See note to "Coast Defense in the Civil War, Fort Sumter, S. C. (First Attack)," in *JOURNAL U. S. ARTILLERY*, for March-April, 1912.

† Though not strictly an account of an operation in coast defense, this account of the attack on Island Number Ten is introduced at this point in the series of articles on "Coast Defense in the Civil War," in order to present in chronological order accounts of operations of guns afloat against guns ashore that took place during that war.





stream from Battery No. 4. Owing to high water, part of the parapet of Battery No. 1 (redan) was washed away and the three 32-pounders could not be used.

There was also a floating battery, mounting nine guns; so the Confederates had some 52 guns in the locality.

Some miles lower down the river, below New Madrid, Mo., but on the Tennessee shore, were other batteries.

The strength of garrison manning the Confederate works was nine companies of artillery and some others of infantry; the actual garrison is not definitely stated.\*

*Courtesy of The Century Co.*

1278

#### OPERATIONS ABOUT ISLAND NUMBER TEN

This map is based on two maps made in March, 1862, by Captain A. B. Gray, C.S.A., and on official reports

The elevation of Island Number Ten was about ten feet above low water; and, though its eastern front faced fairly directly up-stream for a distance of about 4500 yards, yet, on account of bars, the usual channel for steamers within about

\* Brigadier General J. Trudeau, C.S.A., Chief of Artillery, in his report of March 29, 1862, relative to the defense of Island Number Ten, states: "This arrangement gives me four detachments for each gun; an invaluable resource in a prolonged action."—*Editor*.

2500 yards of the up-stream side of the island was not direct, but more or less parallel to the fortified eastern front.

The Federal forces engaging the batteries consisted of:

- 6 ironclad gunboats,
- 1 wooden gunboat (*Conestoga*),
- 16 mortar boats, mounting each one 13-inch mortar.

#### NARRATIVE OF EVENTS

Orders having been issued to make preparations for this expedition, Flag-Officer Foote reported to General Halleck that he was ready to move March 12th, with seven gunboats and ten mortar boats, but that he was waiting for the Army. He was directed to move on the morning of March 14th. Transports with three or four regiments joined him, coming from Cairo, Bird's Point, and Columbus. The force arrived off Island Number Ten at 9:00 a.m. March 15th. Rain and fog prevented the flotilla's getting into position, with the exception of two mortar boats, whose purpose was to ascertain the range.

Early on the morning of the 16th, the two mortar boats shelled the encampments of some Confederate regiments, firing also on the batteries on Island Number Ten, the floating battery, and the batteries on the Tennessee shore.

On the 17th, soon after day light, the mortar boats being in position,\* the *Benton* was lashed between two other steamers (the *Cincinnati* and the *Saint Louis*), and with the remaining ironclads made an attack on the forts at a range of 2000 yards or more. It was not considered advisable to come in closer, on account of the rapid current's rendering the boats so unmanageable as to create danger of their being carried under the Confederate guns. Moreover, nearer approach would have exposed the bow and quarter of the vessels, their most vulnerable parts, to a fire from six other batteries, mounting some forty-three guns. The gunboats opened fire on the upper (redan) fort on the Tennessee shore at 12:00 m., and continued to give and receive quite a brisk fire till darkness obscured the forts from view. All five of the batteries on the Tennessee shore took part in the return fire. During the engagement between the gunboats and the forts, the ten mortar boats shelled the troops which were not manning the batteries

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\* The mortar boats were near the Tennessee shore and about 1800 yards from the redan battery. (See page 147, vol. viii, Series I, Official Records of the Union and Confederate Armies.)

and compelled them to withdraw out of range. The upper fort was badly cut up by the *Benton* and the other boats with her, one of the fort's guns being dismounted and the men at times having to abandon the batteries. The *Benton* received four shots, and a rifle burst on the *Saint Louis*, killing and wounding some fifteen men, while the *Cincinnati* had her engines injured. The shells fired by the flotilla burst prematurely, because of poor fuses, which were said to have been manufactured before the Mexican War.\*

On the 18th the upper fort was again attacked "at long range," another of its guns being dismounted. The mortar boats on this occasion fired on the lower works, the encamped troops having all been driven down the river out of range. The firing was now kept up day and night to prevent repair of the earth works.†

On the 20th the bombardment was continued, still another gun being dismounted in the upper battery, which was silenced after half an hour.‡

On the 26th, Flag-Officer Foote reports having six iron-clad gunboats, sixteen mortar boats, and the wooden gunboat *Conestoga*—an increase of six mortar boats over his original equipment.

On April 1st a storming party of 100 men landed at the upper, or No. 1, battery on the Tennessee shore, and spiked all the six guns, the Confederates retreating. The Federal storming party withdrew after their work was done.||

On April 3rd, three gunboats and three mortar boats fired for more than an hour against the floating battery moored off Island Number Ten. As a result, the battery cut loose and drifted down the river some two or three miles. The return fire is said to have had no effect on the squadron.||

In the meantime General Pope, in command of the Federal forces, immediately after taking New Madrid had given his attention to intercepting navigation of the river below Tiptonville. This he successfully accomplished by establishing batteries at several prominent points along the river. He had

\* Report of Flag-Officer A. H. Foote, U.S.N., under date of March 17, 1862. (See pages 693 and 694, vol. xxii, Series I, Official Records of the Union and Confederate Navies.)

† Report of Flag-Officer A. H. Foote, U.S.N., under date of March 19, 1862. (See page 696, *ibid.*)

‡ Report of Flag-Officer A. H. Foote, U.S.N., under date of March 20, 1862. (See page 697, *ibid.*)

|| Reports of Flag-Officer A. H. Foote, U.S.N., under dates of April 2d and 3d, 1862. (See pages 706, 707, and 709, *ibid.*)

also, while waiting for Flag-Officer Foote to run by, begun work on a canal across the peninsula north of Island Number Ten, with a view to connecting the main channel above and below. The canal was completed and four steamers sent through on the night of April 6th. Flag-Officer Foote was reluctant to run by Island Number Ten, not wishing to risk his boats at such close range, they having to pass some batteries at 300 yards. Finally, however, after much correspondence, but before the completion of the canal, Flag-Officer Foote allowed Commander Walke, who had volunteered for the duty, to attempt to make a runby with the *Carondelet*. Accordingly, the *Carondelet* got through on the night of April 4th, during a terrific storm, without any damage whatever, arriving at New Madrid about midnight. Forty-seven guns had fired on the boat, but the shots had passed some two hundred feet above her.\*

Flag-Officer Foote was asked to send another boat, but he demurred at first, because of the risks involved; for, as he said, the boat would have not only to pass seven batteries, but also have to approach head-on eleven guns on Island Number Ten and pass within 300 yards of some thirty strong fortifications. But finally he said he would get another boat ready, and try to run by if the night of April 6th were favorable.†

General Pope asked that the *Carondelet* on April 7th cover a crossing of troops and assist the Federal shore batteries in engaging the Confederate batteries below and on the opposite shore from New Madrid. General Pope's plan was to cross his force, 3500 men at a time, and attack the Confederates in the rear. Commander Walke cooperated as requested, silencing and spiking all the Confederate batteries on the Tennessee shore of Madrid Bend. He reported "a desperate resistance" by the lower battery, which comprised two 64-pounder howitzers and one 64-pounder navy gun, all of which were put out of action by the gunboat's fire, two being dismounted and one disabled.‡

About 2:00 a.m. of April 7th the *Pittsburg* ran by the forts uninjured, thus making two boats below Island Number Ten, the remainder of the flotilla being still above.

General Pope now made ready to assault the works near

\* See pages 708 to 711, vol. xxi, Series I, Official Records of the Union and Confederate Navies.)

† Report of Flag-Officer A. H. Foote, U.S.N., under date of April 6 [5?], 1862. (See pages 711 and 715, *ibid.*)

‡ Report of Major General John Pope, U.S.A., April 6, 1862, and report of Commander Henry Walke, U.S.N., April 7, 1862. (See pages 717 and 718, *ibid.*)

Island Number Ten, attacking in rear, while the flotilla was to attack in front. As soon as the movement was gotten under way, the batteries on the Tennessee shore were hurriedly evacuated, the troops there retiring down the river and abandoning the forces on Island Number Ten to their fate, not even advising them of the abandonment of the works on shore. Two officers from the forces on Island Number Ten boarded the flagship *Benton* and surrendered the works to Flag-Officer Foote. General Buford and his troops took possession of all works on the island and on the Tennessee shore. Besides the armament, there fell into the hands of the Federals seventeen officers, about five hundred men, four steamers afloat, two steamers and a gun boat (*Grampus*) sunk, but capable of being raised, and the famous Confederate floating battery.\* The Confederates retreating from the batteries on the Tennessee shore, together with such as got away from Island Number Ten, encountered the Federal forces at Tiptonville, and, amid great confusion, were driven into the swamps, where, finding themselves entirely cut off, they laid down their arms. The force surrendered was approximately 7000.†

The records of this action as to hits, expenditure of ammunition, etc., are very incomplete on both sides; but it appears that there was comparatively little damage done the land batteries or the boats engaged, due, probably, to the long range firing that was indulged in.

### COMMENTS

1. This is another example of a place well fortified against naval attack being taken as a result of land operations: the works, successful in their resistance to the flotilla, were abandoned when their rear was threatened.

2. The naval activities about Island Number Ten afford examples of runbys successfully executed under cover of darkness, notwithstanding that the available waterway was very restricted and close to the guns.

3. The foregoing comment, in the light of the correspondence antecedent to the runbys executed by the Federal

\* Report of Major General John Pope, U.S.A., dated April 7, 1862, and report of Flag-Officer Foote, U.S.N., dated April 8, 1862. (See pages 719 to 721 of vol. xxii, Series I, Official Records of the Union and Confederate Navies.)

† Report of Major General John Pope, U.S.A., under date of May 2, 1862. (See pages 85 to 90, vol. viii, Series I, Official Records of the Union and Confederate Armies.)

flotilla, but emphasizes the reluctance a naval commander feels in taking the supposed risk.

4. The work of the mortar boats against the encamped troops was conspicuous.

5. Island Number Ten is an example of the futility of long range bombardment.

6. The difficulties occasioned an energetic and determined commander through lack of the presence of a commander in chief of all forces engaged, is strongly emphasized in the operations against Island Number Ten.

#### AUTHORITIES

Official Records of the Union and Confederate Armies, Series I, Vol. VIII, pages 76-186; and atlas.

Official Records of the Union and Confederate Navies, Series I, Vol. XXII, pages 685-758.

Battles and Leaders of the Civil War, Vol. I, pages 437-446.

From Fort Henry to Cornith (Campaigns of the Civil War Series), pages 66-90.



loading were the same in both cases, and both charges were practically burned in the gun. The grains of powder of Table B (ballistite) were cubes 0.3 inch on a side; while those of Table C (cordite) were long slender cylinders 0.3 inch in diameter. The initial surface of combustion of the former charge was, therefore, fifty per cent greater than the latter, and from this we should expect that the pressures and velocities due to the charge of ballistite would be greater at first than those produced by the same charge of cordite, even though this latter is the stronger powder, giving a muzzle velocity of 2914 f.s. to the former's 2806 f.s. The force characteristic of the 0.3 inch cordite was found (Interior Ballistics, page 124) to be 2521 lbs.; while that of 0.3 inch ballistite was 2338 (page 143).

TABLE C

Computed velocities, pressures, and pounds of powder burned in an English 6-inch gun for certain given distances traveled by the projectile, and comparison with measured velocities. Charge 20 lbs. of 0.3 inch cordite. Density of loading 0.4. Weight of projectile 100 lbs. Density of powder 1.56. Reduced length of initial air space, ( $z_0$ ) 3.0332 ft.

No. of plug	Distance traveled in feet "	$\frac{u}{x} = \frac{u}{z_0}$	Measured velocity f.s.	Computed velocity f.s.	Measured-computed	Computed pressures lbs. per sq. in.	Powder burned ( $y$ ) lbs.	Remarks
1	0.08	0.0264	60	129	—69	16657	2.814	
2	0.28	0.0923	245	316	—71	27508	4.916	
3	0.48	0.1582	395	458	—63	31973	6.266	
4	0.88	0.2901	615	681	—66	36414	8.132	
5	1.28	0.4220	810	856	—46	37291	9.446	Maximum pressure. Mean crusher-gauge pressure, 37184 lbs.
6	2	0.6594	1090	1102	—12	36076	11.162	
7	3	0.9890	1370	1357	13	32733	12.834	
8	4	1.3187	1570	1551	19	29274	14.014	
9	6	1.9781	1847	1833	14	23466	15.730	
10	8	2.6375	2041	2032	9	19129	16.854	
11	12	3.9562	2302	2301	1	13332	18.280	
12	16	5.2750	2472	2474	—2	9712	19.086	
—	16.6	5.4728	2495	2495	0	9285	19.178	
—	21.6	7.1212	2632	2633	—1	6493	19.696	
13	22	7.2531	2636	2642	—6	6316	19.726	
14	28	9.2312	2747	2747	0	4188	19.974	
—	31.3	10.1	—	2787		3331	20.000	Powder all burned.
—	.1	11.1	0	2816	5	3000	—	
15		11		2834	6	2807	—	
		14.5		2897	0	2189	—	
—			4	2914	0	2038	—	Muzzle.

be made of any essay submitted, which seems to the committee worthy thereof, but to which a prize is not awarded.

(c) Manuscript must be submitted in triplicate. It must contain nothing to indicate its authorship, must be signed with a *nom de plume* and must be accompanied by a sealed envelope containing this *nom de plume* and the name of the writer. This envelope will remain in the hands of the Editor of the Journal and will be opened in the presence of the Coast Artillery School Board, after award has been made by the committee.

(d) All essays to which prizes are awarded, or of which honorable mention is made, will become the property of the Journal of the United States Artillery. These will be published, if approved by the Coast Artillery School Board. All others will be returned to their authors.

(e) All essays must be typewritten, on one side of the paper only. No essay shall contain more than 15,000 words, exclusive of tables, (about 40 pages of the Journal). Manuscript must be received on, or before, December 31st, 1913. It should be addressed Journal U. S. Artillery and the envelope should bear the notation, "Essay Competition".

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# PROFESSIONAL NOTES

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## THE INFLUENCE OF COAST FORTRESSES ON NAVAL STRATEGY\*

By Lieutenant-Colonel W. R. W. JAMES, Royal Artillery

(Concluded)

### Example 2: Trincomalee

I have selected the capture of Trincomalee by Suffren as my second example; not only on account of the fact that, beyond all doubt, the command of the sea was in dispute, but because Suffren, a commander universally acknowledged to be of the first rank, has fortunately left a record of his opinion on the value of this coast fortress.

Let us first take the account from *Naval Warfare*.†

"I think the finest piece of strategy against territory, as it may be practiced by the Naval commander who is not in assured command of the sea, was that exhibited by Suffren in the East Indies in 1782.

"This officer had found himself by actual experiment evenly matched by Sir E. Hughes.

"He had fought three pitched battles with him, one on February 16th, another on April 11th, and a third on July 6th, when each fleet had been of the same numerical strength, 11 sail of the line, but the French loss in killed and wounded had been more than double that of the English.

"At Cuddalore, after the last of these battles, Suffren heard of the approach of two sail of the line and other ships of war, as well as transports. He proceeded to meet them at Batacaloa, a port about 60 miles to the south of Trincomalee, having taken on board 600 or 700 troops.

"Then for a time he was lost sight of by Hughes, who remained fitting at Madras."

Colomb goes on to explain that owing to the s. w. monsoon Suffren could calculate that he had a fortnight before Hughes could arrive, and that he took the place in less than a week.

Hughes had warning four days before Suffren left Batacaloa, and arrived off Trincomalee two days after it had fallen.

Let us consider why Hughes felt the importance of saving Trincomalee. Colomb says:—

"At daybreak in the morning he saw his errand was bootless: that Suffren had outwitted him, and that the French flag had superseded the English on shore."

Those who know Trincomalee will find it exceedingly difficult to regard this as an attack on territory. There is no wealth, no trade, no fruitful terri-

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\* Continued from JOURNAL U. S. ARTILLERY, March-April, 1913.

† Pages 395, 396.

tory, dense jungle surrounds it, even now, for many miles on every side. Trincomalee possesses one thing only, a natural and perfectly sheltered harbor, the only good one in the Bay of Bengal.

The objection naturally arises that Hughes was not based on Trincomalee, but on Madras.

The explanation is that while the s. w. monsoon was blowing, Madras, though then an absolutely open roadstead, was a possible base for a fleet able and anxious to fight, and was nearer that of the French at Cuddalore.

On the change of the monsoon the whole western coast of the Bay of Bengal was unapproachable except at the one point, Trincomalee. Thus the possession of that harbor was an asset sufficient to turn the scales in favor of the side in occupation of it.

Batacaloa, spoken of by Colomb as a port, is an open roadstead, without protection of any sort, and an uneasy and insecure anchorage at the best of times.

I have taken what follows from Laughton's *Studies in Naval History*, pp. 134-7. The English fleet wintered in Bombay, and did not return to the east coast till March, 1783.

"On 24th May it was off Trincomalee, and perhaps meditated an attack on the ships in the outer anchorage; but on closer observation Sir Edward judged they were posted too strongly to permit such an attempt to be made.

"It was at this time Suffren wrote to M. de Souillac, governor of the Isle of France, the following letter, which gives a tolerably clear idea of his view of his position:—

" 'I cannot realize what Sir Edward Hughes' plan is: Does he expect reinforcements; is he looking out for those we expect; or is he waiting till I go to the relief of Cuddalore to attack Trincomalee, which he would capture easily, as I am obliged to take away 500 of the garrison in order that my ships may be—I cannot say manned—but capable of going at all?

" 'Persuaded then that with 15 ships, of which eight only are coppered, I cannot attack 17 which are all coppered, and stronger than mine, which have the advantage of the wind, and owing to their superior sailing can keep it; persuaded also that they have left their 18th ship, with some frigates, blockading Cuddalore, I have sent two transports laden with provisions and stores, in convoy of the *Tendant*, *Cleopatra*, and *Coventry*. I believe that this is the surest way to relieve Cuddalore, without at the same time risking Trincomalee, *on which our existence in Indian waters depends.*' "

Three such witnesses as Hood, Nelson, and Suffren, should be sufficient, but to those who remain unconvinced I can only suggest a careful study of our Mediterranean operations in the War of the Succession in the years 1705-8.

I think no one who compares Corbett's *England in the Mediterranean* with Colomb's *Naval Warfare* can fail to be struck with the difference in breadth of outlook between the two.

Corbett lays before us the strategy of Marlborough himself, at a period when, having recognized the necessity for destroying the French sea power in the Mediterranean, he is combining all the armed forces he can influence to effect his purpose. Yet for Colomb the attack on Toulon "was not properly an attack from the sea, as the troops marched by land, and drew their supplies also from land" (p. 315, *Naval Warfare*). Surely this is a wonderful example of how far a man's mind may be cramped by water-tight-compartment ideas of war, when we learn that "so great was the danger that the

whole Toulon squadron to the number of over 50 of the line were sunk to prevent their being burnt."\*

So with Minorca, Marlborough's despatches put it beyond all doubt that the capture of Minorca was undertaken solely because the sailors considered its possession was absolutely necessary, if England was to keep her grip on the Mediterranean during the winter months. All the notice Colomb takes of the matter is as follows:—

"In October, 1708, Minorca fell to the attack of an army commanded by Lieut.-General Stanhope, when supported and supplied by a fleet, under Sir John Leake, in command of the surrounding waters, acting on the knowledge that the French fleet was in no condition to interfere."†

We will now consider a period which brings out very strongly the strategic value of properly fortified naval bases.

### Example 3: The Campaign of 1759

#### *First Phase*

"In the beginning of 1759 the French had three main fleets in existence.

"There were 12 sail of the line at Toulon, under Rear-Admiral de la Clue. At Brest, under Vice-Admiral Marshal de Conflans, was a force which was counted up to 17 sail by the British scouts in June, and proved to be 20 or 21 sail of the line stronger in November; and in the West Indies a squadron of nine sail of the line under Rear-Admiral Bompart.

"This made up a total of 38 sail of the line capable of being concentrated, had the command of the sea been aimed at, on the English force off Toulon, not exceeding 14 or 15 sail of the line, or on that off Brest, never exceeding 25 sail of the line, but seldom reaching that strength at any given moment."‡

The author here interpolates the intention of the enemy thus:—

"Command of the sea as an end was not, however, thought of. Such concentration as was contemplated did not pass beyond the object of convoy or escort for the armies."

Our regulations advise us that, in writing an appreciation of a situation, it is better first simply to tabulate the forces on both sides, and then to consider the courses open to either side; and always credit the enemy with the intention of doing the right thing. If his subsequent line of action transgresses the principles of sound strategy that is an additional asset to us, but one which must not be reckoned on in advance.

I will therefore simply enumerate the remaining French forces.

Complete transport for 19,000 men lay at Morbihan, a district comprising a group of estuaries opening into Quiberon Bay. Captain de Morogues, with five sail of the line and frigates, was stationed there as escort.

Flat boats and small craft, transport for another army, lay at Havre (whether any escort was attached to this flotilla is not stated).

Five frigates were stationed at Dunkirk.

The British forces were distributed as follows:—

1. A fleet not exceeding 14 or 15 sail of the line, off Toulon, based on Gibraltar under Boscawen.

2. Twenty-five sail of the line, and a powerful force of 50 gun ships and frigates (sixteen according to Schomberg) under Hawke based on Torbay,

\* Volume II, "England in the Mediterranean," 295.

† "Naval Warfare," page 316.

‡ *Ibid.*, page 136.

and ultimately on the Channel ports, watching Toulon, Morbihan, Rochefort, and the Basque Roads.

3. Twelve sail of from 50 to 12 guns under Commodore Boys watched Dunkirk, supported by a squadron of 8 sail under Commodore Sir Percy Brett in the Downs.

The true objective of the enemy was to attain maritime preponderance in the English Channel, either by (1) destroying the British Fleet, or by (2) so effectually containing it that it would be incapable of acting on the lines of communication of an army, thrown across the water, for a sufficient period to allow of the complete crushing of the armed resistance of the British nation.

The British objective therefore was primarily to maintain their maritime preponderance against any combination of the French naval force.

The courses open to the enemy were to concentrate a force so superior on any one portion of the scattered British forces that it would annihilate it, and having succeeded in this, to proceed to deal with the remaining portions in detail.

This could be effected by a combination of:—

- (1) Conflans and Bompert against Hawke,
- (2) or de la Clue and Bompert against Boscawen,
- (3) or Conflans and de la Clue against Hawke.

The course adopted by the British to meet these combinations was as follows—to maintain their watch on the different portions of the French navy so as to prevent any of these junctions, and to wait for a chance of fighting any one portion before it could be supported by a second.

Let us now see what influence coast fortresses had upon this decision.

The most obvious method of preventing any of these junctions was by defeating any of these French forces forthwith. For instance, why did not Hawke smash up the fleet in Brest—his own was superior or he could not have blockaded it—or why should not Hawke and Boscawen united have first crushed the Brest force, and then turned on Toulon? The answer is that the difference in force was more than counter-balanced by the strength of the fortified port.

The maintenance of their force in an inaccessible position could not, of course, directly help the French to gain the necessary command of the sea, but it gave them the following indirect though none the less real advantages:

1. It enabled them to choose their own time to take the field with their full force.

2. The maintenance of the blockade weakened the enemy, for:

- a. His personnel suffered in health,
- b. His material was exposed to the wear and tear of the elements.

These conditions necessitated a proportion of the blockading fleet being always absent in order to refit, and rest their crews, as well as to replace casualties caused by sickness. As the available personnel was invariably limited, there was a serious drain on the resources of the country. The proof of this was the resort to pressgangs as a means of filling up complements. This was partially counter-balanced by an attendant disadvantage if the blockade was carried on for any length of time. It was this; the crews missed the training gained by service afloat, and, in addition, there may have been some loss of morale.

Colomb, quoting as his authorities Burrow and Burchett, appends the following as a footnote to his narrative:—"Hawke was able to maintain a winter blockade of Brest, but still bitterly complained of the badness of pro-

visions, especially beef and beer, and had men constantly 'falling down with scurvy,' but this was a wonderful improvement on 1695, when the mere fitting out of a winter fleet put 500 men on shore sick, and still left the fleet unhealthy."

Commenting on the dispositions, he remarks:—

"To the sound mind of Pitt, and the instructed intellects of his naval supporters and advisors, the mere existence of these fleets was full protection to the coasts of the United Kingdom in the first instance, and afterwards cover for the more direct destruction of the enemy's invading material, and immediate prevention of even the issue of invading forces from the watched ports. Not, of course, that danger did not arise, but that it came more from the division of the naval force into several groups, which might be incapable of supporting one another, than from any removal of the bulk of the naval force to the immediate neighborhood of the enemy."

This paragraph contains a distinct admission of the fact that the French dispositions compelled the superior British force to adopt a watching attitude, that is to surrender the initiative, and to place their superior force at a strategical disadvantage, and it appears beyond doubt that this must be attributed to the strength of the French naval bases.

#### *Second Phase of the Campaign of 1759*

The next phase in the campaign is the escape of de la Clue from Toulon owing to the withdrawal of Boscawen's fleet to refit at Gibraltar.

Boscawen took all the precautions possible, with the force at his disposal. The distance from Gibraltar for a sailing ship was too great for him to refit by detachments, and thus he had to remove his whole fleet at the same time; leaving look-out vessels to acquaint him with the enemy's movements. The result was that de la Clue did get out of the Mediterranean. "Boscawen's ships were still in the middle of refitting: their sails were unbent, and some of them had their top masts down."

That a junction was not effected between Toulon and Brest fleets was owing to the personal element entirely. Boscawen displayed extraordinary skill and energy in getting his fleet to sea, and de la Clue made a tactical error that could not have been reckoned on beforehand.

Here we have again the naval base exerting its influence. The distance of the British base, Gibraltar, was too great for an effectual blockade to be maintained on Toulon. As we have already seen, Hood and Nelson, in later days, brought this fact very prominently to notice by their strenuous efforts to acquire a more suitable base against the same objective.

To continue the narrative: de la Clue through a series of blunders divided his fleet. He issued orders for his ships to rendezvous at Cadiz, recognized his error, issued other orders to continue the course, but did not insure that these orders reached the several units. The result was that part of his fleet, five battleships and all his three frigates, went to Cadiz. He waited for them, was caught by Boscawen, and the remainder of his fleet was hopelessly defeated, two battleships being burnt, and three captured. "Two made their escape, one reached Rochefort and the other the Canaries in safety." Is not this phase an illustration of the oft quoted criticism, "Order, counter-order, disorder?"

Admiral Colomb continues\*—

\* "Naval Warfare," page 141.

"The conjunction of the Toulon and Brest fleets was entirely abandoned, and those French ships which had got into Cadiz, only thought themselves too happy to escape to Toulon as late as the 17th December.

"There was still the combination of Admiral Bompart's squadron with that of de Conflans, and against this Hawke was taking all possible steps. He was primarily concerned in a close watch upon Brest, in order that the fleet there should not be able to put to sea unwatched and unfollowed. The secondary object was as close a watch on the invading force assembled at Morbihan. But the greater danger was the junction of the Toulon fleet with the Brest fleet, and even after he had heard from Boscawen of the result of the battle of the 18th and 19th August, he saw no cause to relax his vigilance.

"Boscawen wrote on the 20th, and did not then know that half of the French fleet was in Cadiz, and capable of being masked. So that when Hawke, in the latter end of August, heard that Bompart had actually sailed from America, there was a possible combination at or near Brest of an exceedingly serious character. Bompart might make for Rochefort, and the majority of de la Clue's fleet also, as a preliminary, and if Brest were opened by heavy weather driving Hawke off, a junction might prove to be easy. He had not force enough to watch Rochefort as well as Brest. 'If,' he wrote, on the 28th August, 'M. Bompart's destination should be Brest, I shall do my utmost to interrupt him. But should he be bound for Rochefort, I must not think of him,' for the reason that a detachment to Rochefort, though enough to meet Bompart's nine sail of the line, would leave him too weak even for Conflans, certainly too weak for the missing ships of de la Clue's fleet, and that of Conflans together."

Here is another instance of the value of the naval base. Rochefort affords an opportunity of the weaker side improving its strategical position with regard to the superior naval power. We have the admission of Hawke himself that he is unable to prevent it.

The advantage to be gained by this reported move was that a considerable additional force would be transferred into the actual area of operations.

It will be readily understood that concerted action would be much easier directly orders could be transmitted to the several French squadrons by land, owing to the relatively short time they would take, and also to the fact that the messenger was no longer liable to capture by the enemy.

### *Third Phase of the Campaign of 1759*

To continue the narrative: Hawke, having heard that the remnants of de la Clue's fleet were shut up in Cadiz, weakens his own command by two detachments, one under Geary to bar Bompart's entry into Rochefort, another under Captain Duff to watch Morbihan. Geary, however, is recalled when information is received that Bompart is not likely to leave America at present.

On the 9th November the strategical disadvantage of the British disposition is made apparent, "another westerly gale, which had been blowing three days, so increased that it drove the English back into Torbay again, whence it was not possible to put to sea finally till the 13th."

Conflans is thus enabled to put to sea, and effect one of the combinations that would enable him to attack one portion of the scattered British forces with advantage.

That he failed to do so was an error on his part that the British strategists could not reckon on.



Bompart actually entered Brest before Conflans left, but his squadron did not accompany that of Conflans. The latter made for Quiberon Bay, but a strong easterly gale carried him 180 miles w. of Belleisle.

Captain Duff was probably saved by this fact, for when Conflans sighted Quiberon Bay on the 20th, the squadron of the former, which had been lying there watching the armament, was seen making all sail to escape; before Conflans could destroy this detachment, Hawke, who with untiring vigilance and energy had tracked him down, intervened; the strategical advantage had been lost; Conflans declined the combat, and in trying to evade his enemy suffered a crushing defeat.

Deeply interesting as the account of this glorious display of hardihood and professional skill must of necessity be to all of our race, it will be readily understood that I must omit any account of it.

No landsman is competent to do justice to the subject, when tactics, taking the place of strategy, needs the trained intelligence of the naval expert. In addition, it is entirely outside the scope of my paper. The results of the action are, however, material and I give them briefly in Colombs' words:—

“The French fleet, in short, was totally broken up and destroyed. Of the 21 sail of the line which had left Brest the week before, two were driven ashore and burnt; two were sunk; one was wrecked off the Loire; one was taken; 11 saved themselves by throwing all their guns and stores overboard, and escaping into the shallow waters of the river Vilaine; while eight only made good their retreat to Rochefort.”

Once more we have the naval base exerting its influence. Rochefort, by affording protection to the defeated combatants, saves a considerable portion of the unfortunate fleet from annihilation.

It might be argued that the Vilaine did the same, so let us glance at the difference.

The ships which entered the Vilaine were no longer fighting units, for they had parted with all their power of offense. As a matter of history, I believe it took many months to get any of them out again, and longer still to convey them round to a naval base, where they could once more be restored to their status of ships of war.

One more incident in this period requires notice, I give it in Colomb's own words:—

“As a direct employment of the cover gained by the masking of the French fleet at Brest, Rear-Admiral Rodney, with a squadron of 60- and 50-gun ships and bomb vessels, proceeded in July to bombard Havre and to destroy the invasion flotilla.

“It was manifestly weak to prepare the transports, as in the case of Havre, in so exposed position as to leave them open to destruction by shell and carcasses.”

This appears a good example of the danger of imperfectly protected naval bases.

#### *Thurot's Squadron*

The proceedings of the French squadron at Dunkirk during this period receive scant notice from Colomb. His only allusion to it is as follows:—

“It is only necessary to add to the narrative the statement that M. Thurot's expedition proved itself the most successful of all, inasmuch as on the 12th October he escaped to sea with his squadron, taking advantage of a gale which drove Commodore Boys off his station. His good fortune followed

him so far as to permit him to gain the neutral port of Gottenberg in Sweden, and afterwards that of Bergen in Norway, where the squadron lay till next year."

Laughton throws a rather different light on the exploits of this somewhat notorious character.

Thurot's squadron, consisting of four frigates and two corvettes, carried about 1200 soldiers under a major-general. Laughton mentions that besides passing through the blockading squadron he took several prizes on his way to Gottenberg. It is impossible to give his adventures at length; from the first the soldiers and sailors were on the worst of terms, and this paralyzed his plans. In spite of everything, however, the fact stands out he entered Belfast Lough, attacked and took Carrickfergus, and levied a contribution from Belfast. Unfortunately for him he was delayed three days by stormy weather, and so the Government were able to bring up a small squadron from the south of Ireland.

"It cannot but appear strange that there should have been at that time no ship of war in northern waters; for it had been known for weeks past that Thurot was on the coast, and great alarm had been felt at all places which were or thought they were worth attacking."

Laughton describes how volunteers turned out at Whitehaven and Liverpool, and remarks that in neither case was there any attempt to defend the shipping. He continues:—

"Notwithstanding all this preparation and excitement, no ships had been sent north; and when the Duke of Bedford, then Lord Lieutenant of Ireland, had news of the landing at Carrickfergus, he had to send, quite promiscuously, to the different seaports, to inform the captains of any of His Majesty's ships, that might happen to be there, of the enemy being on the coast. Luckily, and only luckily, there did happen to be three frigates at Kinsale. They belonged to Hawke's fleet on the coast of France, had been blown off their station, had run short of provisions, had put into Kinsale, and had been detained by a succession of southerly gales. Thurot was overtaken, and after one-and-a-half hour's action was killed and his ship struck, the other French ships surrendered, practically making no resistance (28th February, 1760)."

It is to Laughton's summing up that I wish to draw your attention.

"There can be little doubt had Flobert (the French general) entered into Thurot's views and schemes, Belfast would have been sacked. Against a sudden onset such as Thurot proposed, there was no possible means of effective resistance; though after three days' delay things would certainly have been very different.

"And the history of Thurot's whole career, and more especially of this last campaign, seems to me to show that a naval force, however numerous and active, is not in itself sufficient to protect our commerce from loss, our coast from insult, and our towns from pillage, at the hands of a small squadron, or even of a single ship, commanded by a man of talent and enterprise.

"That Thurot failed in inflicting very serious loss on our towns and our shipping, seems to have been due not to any wise precautions of the Government—though the elder Pitt was Secretary of State—not to the superior might of our Navy, though that crushed him at last, but to the exceptional severity of the season, to the inherent weakness of the French sailors, the inefficiency of the French equipment, and the bad discipline of the French soldiers.



"But it is not wise always to trust our safety, our prestige, or our honor, either to the caprice of the weather or to the presumed incapacity of a possible enemy."

Though I am using Thurot's operations as an argument, nothing is further from my intention than advocating a wholesale expenditure on fixed armament for coast defense. My whole object is to dissociate the naval base from being considered in any such category.

Thurot was one of the bold thinkers who advocated a raid on Portsmouth. Had any one of our naval bases been without fixed defenses, it seems probable that his swoop might have been directed against it; in that case the personnel would not have been rendered disheartened and disloyal by the great hardships they had actually endured before being given the opportunity they misused.

#### Example 4: Tangiers\*

I have selected Tangiers as an example of a naval base maintaining itself for a considerable period without any support from a fleet.

The title to Tangiers was acquired by the marriage of Charles II. with the Infanta of Portugal.

In spite of the political intrigues and threats of force on the part of Holland, France, and Spain, it was actually occupied by British troops in January, 1662. The Portuguese garrison, being in great straits owing to Moorish activity, begged the British admiral, the Earl of Sandwich, for aid; this was given, and the place taken over by the English.

Danger at once threatened. Spain and Holland both began fitting out fleets, and Guylan, the Emperor of Fez, attacked the place with a formidable army.

"Lord Rutherford, the late governor of Dunkirk, a Scottish soldier of fortune, who had risen with high distinction to the rank of lieut.-general in the French service, was appointed to the command, and created Earl of Teviot.

"Charles determined to devote £30,000 a year to constructing a harbor.

"Teviot (Rutherford) got to work at once upon the fortifications, and advanced forts were commenced, and the whole line of outworks strengthened with every device which the latest military science could invent.

"Scarcely were the additions complete when Guylan appeared in force, and made a determined attack upon the new works.

"As the assault was delivered between twelve and one, when the men were dining, it was to some extent a surprise; but, thanks to Teviot's scientific preparation, and the energy with which the troops showered hand grenades on the Moors, they were driven back with heavy loss."

Teviot continued strengthening the place, and defending it against the Moors until he was killed in 1664.

Holland was now threatening war.

"De Ruyter with a fresh 'corsair' squadron had been sent down to the straits.

"So soon as Teviot's disaster was known in England, Col. Fitzgerald, an Irish officer, who had been formerly deputy governor, was sent out with reinforcements to take charge, and he actively proceeded to complete Teviot's works. By the middle of July Fanshaw (Sir Richard Fanshaw, envoy extraordinary at Lisbon) could write home again:

\* Corbett. "England in the Mediterranean." Volume II, page 36, etc.

“ ‘Now that all is exceedingly well at Tangier, even before the recruits’ arrival, give me leave to say my thoughts; that whether the King have peace with all the world or must have war with all the world, nothing like Tangier, with the mole speedily finished to perfection, in order, to the quiet enjoyment of the one, or vigorous prosecution of the other.’

“The war with Holland broke out, and in 1665, in pursuance probably of the old policy of concentration on the enemy’s main fleet, Allin was now ordered home with a convoy, and the straits were abandoned to the Dutch.

“Fanshaw’s only anxiety was lest enough ships should not be left to make our state good in the Mediterranean against an upstart fleet which the Dutch were then scrambling together.

“But no squadron was spared for Tangiers . . . . . and during the summer, while the war was raging in the narrow seas, the upstart Dutch fleet blockaded the port.

“But it mattered little. It had been fully provisioned, and the mole was so far advanced that a battery had been established upon it that kept the enemy at a distance. The blockade was consequently loose, and easily run by the British frigates that from time to time appeared with convoys or despatches.

“Merchantmen too were able to use it as a port of refuge in running the gauntlet through the straits. In the autumn a fleet of 20 Levant merchantmen and victuallers for Tangier, under a weak convoy arrived.

“The Dutch attacked, and though they defeated the warships all but four of the merchantmen got safely into Tangier and were able to pursue their voyage. The effect was—according to a calculation made for the first year of the war—that the Dutch did not capture enough prizes to cover much more than half the cost of maintaining their squadron.

“In vain the Spanish officials in Andalusia did their best to thwart the progress of the port; in vain they continued their intrigues with Guylan.

“The place throve in spite of every difficulty; the mole pushed further and further to seawards; and in the face of every enemy England was slowly locking her hold on the Mediterranean.”\*

I wish time permitted to follow this fascinating history of Tangier throughout the stormy period of the British occupation down to its final abandonment in 1684.

The lessons that might be drawn from it could not fail to be of great value to all who are called on to garrison coast fortresses; not least amongst these are the interdependence of the fleet and the base on each other, and the proof of how successful a defense can be maintained with inadequate resources by commanders who really know their business.

The achievements of men like Teviot, Fitzgerald, Fairborne, Sackville, and Kirk, should hearten the despondent officer who sees no chance of distinction in such a position. Had any of these soldiers been in command of Trincomalee, would it have fallen to Suffren?

The perpetual political intrigues throughout Europe (as revealed by Corbett), which were carried on to oust the British from their commanding position, should restore confidence in the value of such strategical outworks of the Empire in the minds of those who have power to weigh evidence.

The methods by which the final abandonment was brought about have a peculiar interest of their own.

The dispatch of Lord Dartmouth and Pepys, as a Committee of Inquiry

\* Corbett. “England in the Mediterranean.” Volume II, page 36, etc.

on the value of the Fortress, with their findings already drawn up, but with their evidence still to be collected, coupled with the removal of the Admiral—Herbert—(afterwards Lord Torrington), a man “whose opinions could not be ignored, and whose stubborn independence, and strong convictions, were difficulties which could not be faced,” cannot but suggest that future historians of our own times may also show that strategical considerations have not received due weight in parallel cases.

#### Example 5. Cadiz and Vigo Bay\*

The naval campaign of 1702 affords a comparison between the strength of a properly defended naval base, and hasty field works, extemporized for the protection of a fleet, seeking the shelter of an unfortified harbor.

Sir George Rooke, with 50 sail of the line, together with transports carrying 12,000 troops, under the Duke of Ormonde, was despatched against Cadiz.

It having been ascertained by preliminary reconnaissance that there was no probability of naval interference, the expedition arrived off Cadiz on August 13th.

The town of Cadiz lies at the end of a narrow peninsula stretching to the north-westward for about five miles from the main part of the Isle of Leon. The peninsula runs out into, and partly shelters from westerly and south-westerly winds, the Bay of Cadiz.

The eastern shore of the bay is intersected by streams and marshes, and a narrow channel runs to the southward and eastward along the eastern side of the peninsula, forming the inner harbor of Cadiz, and it was guarded near the entrance by the fort of Puntalis on the southern or Cadiz side, and by the fort of Matajordas on the northern side. Cadiz itself was guarded by the fort of St. Sebastian on its outer or western side, and across the bay to the northward was the town of Rota, and to the north eastward the fort of Sta. Catalina, while in the same direction, but further up the bay, was the town of Puerto Sta. Maria.

The plans adopted by Howard and Essex were not followed, “but a landing effected between Rota and Sta. Catalina, a mile from the latter place, so that its fire did not effect anything against the troops. A little four-gun battery offered a slight opposition to the landing, but on the approach of the troops the Spaniards deserted it, and spiked the guns. Rota at once surrendered, and the army marched to Puerto Sta. Maria, which was found to be deserted.” The soldiers began plundering, and got out of hand.

Sta. Catalina fell easily to a detachment sent against it.

The usual disagreement between the naval and military commanders broke out. Eventually an attack on Matajordas was begun. The ground around was low and swampy, the guns were difficult to work, and the fire, not only from the fort, but from the galleys in the inner harbor, was severely felt. The siege dragged on for a fortnight, and was then abandoned by mutual consent.

The fleet was going home when information arrived that 30 French ships of war, convoying 22 Spanish galleons, had entered Vigo, and an attack was determined on October 7th.

“Vigo Bay is a long tapering inlet running from the sea to north-eastward, and extending for some two miles until it narrows into the Estrecho

\* “Naval Warfare,” Colomb, page 283.

de Raude, which is only some 600 yards across, and then, inside this narrow passage, the water broadens into a sort of a lake. . . .

"What may be called the entrance to the Bay of Vigo is about one-and three-quarter miles across, and at the time I write of, there do not appear to have been any batteries or fort there.

"The town of Vigo was itself defended by some works, but they were not of any magnitude, and did not affect Sir G. Rooke's proceedings in any way."

Chateau Renault had drawn the whole of his ships and their convoy through the Estrecho de Raude, and forts and batteries had been erected on each side of the strait at its narrowest part; the works on the south side mounting 38 and on the north 17 guns.

A boom connected the two forts, and obstructed the passage, and far within the boom the French fleet was anchored in the form of a half moon, intended to protect the galleons.

On the 10th October Sir G. Rooke's fleet passed up the bay.

It was fired on by the forts of Vigo in passing, but without effect, and it anchored above the town to observe the situation, and mature the plan.

It was decided in the first place to land sufficient force to capture the batteries on the south side, and that when the English flag should be hoisted as a sign of the works having changed hands, 25 of the ships should proceed to break the boom, and pass on to attack the French.

The Duke of Ormonde landed at 10 a.m. with 2000 or 3000 men. The book from which Colomb quotes\* makes it clear that the fortifications were merely temporary trenches, and batteries, presenting no obstacle to a rush, and that there was no real garrison, the defenders being landed from the ships.

"We had no sooner took the platform, on which were 38 cannon, but the detached ships which were drawn up in line of battle began to sail. Admiral Hopson with undaunted courage leading the van, and forced the boom with his ships.

"The only casualties in the fleet were inconsiderable, with the exception of those on Admiral Hopson's ship, which was clapt on board by a French fire ship and lost in the action, being killed and drowned, upwards of 100 men.

"Our loss on shore was two officers killed and four wounded, and about 40 private men killed and as many wounded.

"This glorious victory was obtained in about two hours time.

"There were inside the boom 18 French and three Spanish men of war, most of them being line of battle ships; and they were intended to protect 13 rich Spanish galleons carrying from 20 to 30 guns each.

"The result of the attack was that everything that floated inside the boom was either burnt, sunk, or captured.

"Six French ships and five galleons were taken, eight French ships burnt, and four French ships were sunk, the remainder were either burnt or sunk."

It is, perhaps, one of the most remarkable failures of a fortified port to protect a fleet which had sought its shelter.

From the passage quoted it would appear that the ships had disembarked and stores for the land defense of the entrance, and must therefore have

ed the position so arranged more secure than it would have been had

th ships in the outer harbor, in order to meet the enemy broad-

there, placing only the galleons in the inner lake, where it

a that they would be out of harm's way.

rtial Account," etc., pages 21-25.

Modern science cannot be said to have greatly advanced on the method of land defenses adopted by Chateau Renault. But then, probably, modern science could not better the method of attack decided on by Sir G. Rooke.

As I drew my narrative from Colomb it seemed only right to also quote comments on the action.

How the position taken up by the French fleet can have appeared to him to merit the title of a fortified port I cannot explain—but a few guns, mounted on temporary platforms, and guarded against land attack by nothing better than hasty field entrenchments, did not constitute a coast fortress, in those days at any rate.

To those who may think that I am treating a battery mounting 20 guns rather lightly by alluding to its armament as a few guns, I would point out that they could not have possessed the tactical advantage of similar artillery sited in permanent works, and were therefore called on to engage a line of battle ship's broadside on practically equal terms, even if they were of equal caliber.

This latter point is at least doubtful, as the time limit makes it improbable than anything heavier than upper deck guns were landed from the fleet.

Colomb suggests that political intrigue may have had a good deal to do with the failure of the attack on Cadiz, and it may well have been so, but in that case the same cause may equally well explain the surrender of Rota and Sta. Catalina.

My object is to bring out the fact that, against the same force, the permanent works of Matajordas remained intact after a fortnight's siege operations; whereas two hours sufficed to overwhelm the extemporized defenses at Vigo Bay.

#### THE BRITISH ASPECT OF THE QUESTION

One more aspect of the question remains to be dealt with, viz., the value of fortifications to our own ultimate naval bases.

Perhaps this is the most vital question of all, as any miscalculation in this respect would mean, not loss of maritime preponderance in some sphere where it might eventually be regained, but an absolute collapse of further resistance and practically the ruin of the Empire.

To make my argument clear I must first inflict on you the particular doctrine I am trying to controvert.

Colomb, in reviewing the results of the campaign of 1744, 1759, 1779, and 1805, remarks,

"In no case, through all these series of operations, can we bring our fortifications into relation with our fleets at all in the home waters. On the other hand, there were always the closest relations between the French fleets and the fortifications under which they sheltered themselves. Our admirals never thought about their bases being fortified, being fully persuaded that they were themselves their defense. And the mere fact that the open anchorages of Cawsand Bay, Torbay, St. Helens, and the Downs, were their *points d'appui*, accounts for the absence of all expressions of doubt as to the support which might be afforded by the shore."

As regards the Maritime War, 1779-82, Great Britain was inferior to the allies, France and Spain, and Mahan blames their commanders for not bringing the British fleet in Torbay to action.

We may therefore suppose, in this instance at least, that the British

admiral was not unmindful of the fact that he had fortified ports to fall back on.

It is never very safe to reckon that a country, where political power rests in the hands of the masses, will maintain, in peace time, such preponderating naval armaments, that the situation of 1779 cannot arise again; but my present object is to show that our fortified ports have exerted, and may still exert, their influence whilst the fleet is unbeaten.

I must again quote Colomb to show that such a state of affairs is deemed impossible by him:—

“The fact that a fortified Brest and a fortified Toulon has always preserved the French fleet from our assaults is, of course, conclusive as an argument that the naval power which has not command of the sea, may, by means of fortifications, preserve a fleet for a time at any rate. It is a matter of fair reasoning to say, if your fleet is the most precious thing you have, even when it remains in a state of forced inaction, you can preserve it in your harbor by means of local defenses of such strength as will send the enemy anywhere and everywhere before he will be driven to make his attack on the fortified ports. . . . But I conceive we have established the fact that before a country can employ such fortifications at all, she must have surrendered the command of the sea, and if such command has been necessary to her Empire, she must have abandoned Empire.

“Let us for one moment push this thought home as in the applied case of one of our fleets being beaten under the shelter of the Plymouth works. When we think of such a thing, we must, in the face of what has been said, suppose that we have no relieving fleet at hand. Were there such a fleet, it is manifest that the victorious enemy would court destruction in pursuing our beaten fleet up an intricate harbor, where it is liable to be caught by the relieving fleet. We do not, in fact, in our thoughts, admit the existence of a relieving fleet.

“There could not be such a thing at Portsmouth for instance. Yet the theory must be that in some way the command of the sea, which has been lost, can be regained out of Plymouth alone.

“How is the fleet which has been defeated into Plymouth to come victorious out of it? And supposing such a thing possible, how long will it be before this thing happens, and what will the enemy be doing meantime?”

But why should we admit that the fleet in Plymouth is beaten; why does the idea of dealing destruction to a fleet in an undefended anchorage preclude the existence of a fleet in Portsmouth?

It is not necessary to postulate any previous action; supposing war was suddenly declared, or hostilities commenced before declaration, it would not be the first time England was behind-hand in her preparations.

We cannot, owing to the position of our naval bases, and want of accommodation in any one of them, keep our fleets massed in peace time.

It would be quite possible for an enemy's fleet to appear before the undefended port of Plymouth, and force the squadron there to fight at a great numerical disadvantage.

If, as an alternative, it sought refuge “up the intricate harbor,” it would not be necessary to pursue it with one single battle unit. Nothing is so helpless as a battleship in narrow waters; a squadron in the Hamoaze must be anchored, and would present as fair an objective as any destroyer commander could desire, even if we ignore such a temptation as blowing up the magazines at Bull Point.



With Plymouth fortified, the squadron can be in the Sound, practically safe from attack, and ready to effect a junction at any moment with the ships from the Eastern ports.

There is yet another point; anyone, who has watched the passage of big modern ships up and down the Hamoaze, must recognize that, to move a squadron of any size in and out, is a matter of time, and that fortifications allow it to assume a position in readiness in the Sound that it could not otherwise do in the presence of a hostile fleet.

Briefly we may say that, at the commencement of hostilities, the fortifications of naval bases tend to secure the assembly of the fleet from any interruption by sudden attack, in fact afford it time and opportunity for the strategical deployment.

It is not necessary to follow the argument much further. Without an actual campaign as an example we can only surmise, but it must be insisted on that there is no instance of our main naval bases being unfortified at the times when we were most powerful at sea. If they had been, what might have been effected by some of the lighter ships (which, it is admitted, were able to issue from the Channel ports, and prey on commerce, and terrorize undefended coast towns) may be conjectured, and I think no one will deny that steam and high explosives have not lessened the chances of a successful raid by light craft.

It must be remembered that more than once the French government actually considered proposals for a raid on Portsmouth, and it was the strength of its defenses that finally negatived the attempt.

Every successful land commander has invariably provided for the immediate safety of his base, even when his active operations have made such attacks unlikely.

Our naval commanders have found the preparations already made; but this is no reason why the fact should be ignored.

Colomb takes Torrington's predicament in the Channel in 1690 as an instance of the most unfavorable circumstances that an English commander is likely to be placed in.

He says:—

"But he perfectly understood the situation. The mere neighborhood of an inferior naval force which was free to attack was an absolute bar to any operations against our shores.

"A strength," he wrote to the Council, "that puts me besides the hope of success if we should fight, and really may not only endanger the losing of the fleet, but at least the quiet of the country too; for if we are beaten, they being masters of the sea will be at great liberty of doing many things they dare not attempt whilst we observe them, and are in a possibility of joining Vice-Admiral Killigrew and our ships to the Westward."

Colomb adds:—

"No conceivable arrangements of fortifications could have strengthened Torrington's hands, there was no question of fortifications relieving his naval force."

But can we not here see the power of more than one fortification silently exerting its influence on the situation?

The French had the strategical advantage, they were interposed between the two British fleets, though as a matter of fact Killigrew did not arrive in the theatre of operations until after the battle. He then fell back on the fortified port of Plymouth, retiring up the Hamoaze.

It was the existence of Plymouth that enabled Killigrew to approach at all.

How was it that Torrington could leave St. Helens, uncover Portsmouth, and retreat eastward without a thought of the safety of his naval base? The answer is: Portsmouth was secure by reason of its fortifications.

Unprotected, it would not have needed the diversion of a single capital ship to have transformed its dockyard to a heap of blazing ruins.

What prevented the French following up the beaten Allied fleet, which had come "to an anchor at the Nore in great confusion"? In a measure, doubtless, the difficulties of navigation, but was it not also owing to the fact that they had a final retreat into the Medway and Thames?

Owing to the lesson of 14th June, 1667, the Medway was now thoroughly well protected, and Tilbury also was a formidable fortress.

#### CONCLUSION

I have little to say as regards my fourth theorem.

I shall not attempt to lay down any comparative standard of value between guns afloat and ashore, being thoroughly convinced that the tactical value of the latter varies enormously with their siting.

San Fiorenzo is an excellent example of the powers of fixed armament under favorable tactical circumstances.

At Sebastopol five high-sited guns wrought havoc on the British fleet.

Guns mounted ashore simply act as deterrents under normal conditions. If the armament is powerful enough to inflict serious damage on the ship, the latter will avoid the waters commanded by the former.

I think most coast defense gunners would be satisfied to engage a squadron of four armored cruisers of the *Natal* class with half a dozen high-sited 9.2-in. guns, provided there was no dead water from which the armament could be enfiladed.

I think I am not far wrong in assuming the original cost of the necessary works, inclusive of sufficient infantry defenses, to be well under £200,000; that of the ships is nearly £5,000,000.

The coast defense guns will certainly have as long a life as the ships, and when they have to be renewed, much of the original fortress will not require alteration, whereas an entirely new ship has to be built.

The cost of the personnel—especially that of the most important part, the infantry guard—must depend on the class of attack which the fortress is to be prepared to resist.

It has been urged that the advent of the destroyer, the submarine, and the mine, as adjuncts to the defense, will banish the gun from the equipment of the naval base.

The addition of the ram and torpedo to the offensive equipment of ships was hailed with similar prophecies.

It needed the battle of Tsushima to vindicate the position of the gun as the decisive weapon of naval warfare.

If we abandon the gun as equipment for the naval base, as long as ships carry ordnance, our adversaries will maneuver to bring about a situation where the gun will decide the day.

We can only argue by analogy as regards the submarine; but the destroyer figured largely at Port Arthur, in spite of the general want of enterprise on the part of the Russians.



There flotilla encountered flotilla. Usually the Russians were forced to retire, and it was the guns of the fortress which checked the pursuit.

It is not a very large step to assume that in the future all kinds of light craft, including submarines, made use of by the defense, will be encountered by the action of similar vessels.

The theatre of operations, the sea, common to both sides, affords no advantage to either. The defense in this case has no inherent superiority such as the fixed armament possesses in the case of an artillery duel with the attacking squadron.

We here see the weakness of local floating defense.

The assailant, choosing his objective, can concentrate a force superior to that which can be provided for the defense without an absurdly lavish expenditure; especially when, as in our case, there are a large number of strategically vital points in all parts of the world to consider.

If a naval base is attacked we may assume that the assailants will have a numerical superiority in these craft; and, in that case, those of the defense will be driven in; if the fortress is without guns the assailants' artillery will complete the victory.

Whereas, if the menace of the fixed armament remains, the enemies' capital ships cannot close, and their light craft cannot follow up their success. The waters thus preserved are specially important as they prevent the mobile defense being bottled up.

The submarine and destroyer have their parallel in land warfare; they correspond to the light troops thrown out in front of an army in position, or a fortified town; they prevent any advantage being gained by any action short of an attack in force, and yet they could not maintain their position without the support of the main body.

Mines are obstacles, and their utility is governed by the general rules affecting obstacles. They are only of use when protected by effective fire.

Countermining and sweeping vessels will soon clear away these dangers unless approach is rendered practically impossible by the fixed armament.

It is with reluctance that I bring my labors to a close. It is not for lack of other, and perhaps even better, examples, but I think enough credible witnesses have been cited to prove my case to an impartial mind. Those who remain unconvinced of the utility of fortified bases, must elect to ignore the unwavering policy of those strategists who built up England's sea power.

I can only compare them to the rich man, who thinks lightly of money because he has never known the want of it.

—*Journal of the Royal United Service Institution.*



## RECENT DEVELOPMENTS IN BATTLESHIP TYPE\*

BY ALAN H. BURGOYNE, M.P., M.I.N.A.

The subject of this paper has frequently provided the basis of discussion at meetings of the Institution of Naval Architects, yet it recurs with never-ending freshness, for, though the basic principle of ship-type remains largely

\* Read before the Institute of Naval Architects.

the same, the constant advances made in every branch of science tend little to settle opinions or conclusions which for many years now have been matters of controversy. In this review it is desired to trace the rapid evolution of type now in progress, particularly in so far as it touches the ship-of-the-line, or battleship, and to analyze the reasons that have led and are leading to a closer international unity of design than has hitherto obtained.

This may be explained in part by a curious spirit of rivalry new entirely to naval history, and seen in quite minor nations which are building vessels frankly in excess both of their resources and their national needs, and, also, to a complete disregard in almost every case of the geographical limitations which formerly have entered not a little into the consideration of those to whom the framing of programmes is entrusted.

To this side of the question there is no necessity to refer at length, but it is worthy of passing comment that the old distinction of first, second, and third class battleships in their application to nations similarly designated has disappeared, and the premier fighting units of quite small powers, built or building, are now comparable on all counts to those in the front line of their mightiest neighbors.

Leaving this aspect of the case, what is it that controls in the main the development of ship-type? The question is open to a variety of answers, but, accepting the axiom that a warship is solely a means of bringing weapons of destruction into contact with the enemy, or (by reason of their existence) preventing the outbreak of hostilities, we may rapidly extend our argument.

The destructive factor (gun, torpedo, etc., as the case may be) is, therefore, the primary basis. Subsidiary to it we find the defensive factor, and thence enter the realms of strategy and invoke discussion on the value of speed as a strategical or tactical asset. These three desiderata have each their claims, to the equable establishment of which it is essential to bring into line the views both of the naval architect and the naval officer—a problem of abiding complexity.

Opinions as to size, caliber, etc., of guns have invariably been controlled either by the advent of new forms of attack, or else by the tendency in matters of defense, with the result that the war betwixt guns and armor has been unceasing, and that from a time long before “defense” implied the sheathing of the hull, or vital parts thereof, with heavy metal slabs; in no phase of type-progress is the cycle of ideas better evidenced than in this never-ending conflict. The earliest armor-clads (to set a period from which rapidly to trace progress in design) were, in the main, the ships of Nelson’s day modified to meet new conditions. The *Warrior* and her immediate successors were admittedly experimental, and though, possibly, the introduction of armor-belts speeded up the adoption of metal-hulled warships, it largely synchronized with an inevitable change in building material already growing popular with the merchant service.

This method, novel as it then was, of thwarting hostile attack on vulnerable portions of an enemy by iron plates provoked immediate advances in artillery and that weapon which, for many decades, had seen little change, either in caliber or weight of shell, developed speedily in the course of a few years out of all previous conception until the muzzle-loader was approaching one hundred tons in weight. The subsequent progress of the gun to the present day may be outlined in a few brief sentences. For many years two systems of mounting and disposition came into conflict—in rough title, the turret v. the broadside.

## PROGRESS OF ARMAMENT

The latter was fore-doomed immediately it became necessary to reconcile the growing weight of individual weapons with an effective arc of fire. The omega of turret construction in its purest sense was attained in the early *Dreadnought*, *Thunderer*, *Devastation*, and ships of kindred type. Apart from their four heavy weapons, mounted in pairs fore and aft, and training over a large area on both broadsides, these ships carried only a few machine guns which, in the absence at that date of any real torpedo menace, possessed a purpose wholly undefined.

Improvements in the torpedo produced in natural sequence a type of craft especially fitted for its effective use, and each change and advance in torpedo-craft whether surface or submarine, has had a direct and vital bearing upon the armament of the capital ship, to destroy which they were called into being. A secondary armament was little by little introduced, and to it was added a tertiary armament for man-killing purposes to which to-day, with long range torpedoes and longer-range fleet actions, we find it difficult to assign a value. The tertiary armament we may, therefore, in this connection ignore—the secondary armament speedily acquired a dual purpose. The first was to protect the ship against torpedo attack, the second as an auxiliary in inter-fleet actions to the main guns, when it was hoped that their quality of quick firing might not only tend to wreck the unarmored parts of enemy's ships, but, by providing a stream of shells, destroy on their explosion the *morale* of hostile gunners.

The tendency to increase the effectiveness of everything—power, speed, weight, etc., led, as in the case of ships themselves, to the manufacture of yet larger intermediate guns for use in the secondary battery, until to-day (though not all in process of mounting) many gun-makers' lists show a series of calibers rising by differences only of inches or even half-inches from rifle-bore machine-guns to weapons of over a hundred tons. Indeed, the secondary battery gun of to-day would have proved a formidable main armament for a ship some years ago—for example, the 9.2-in. weapon of the *King Edward VII* and *Lord Nelson* classes.

This secondary battery took its place along the broadside, mounted in one or two tiers and flanking the large guns, the total of which custom had fixed at four, paired in two turrets on the keel line, carried forward and aft. So, for a matter of twenty years, design remained practically at a standstill—except, of course, such modifications abroad as arose from international divergence of thought. The above description would incorporate the larger part of those battleships which were built during that period for the majority of big naval powers.

## ORIGIN OF THE DESTROYER

The multiplication of French torpedoboats was the direct cause of creating the destroyer—a type at once copied by all other nations. Destroyers, from an antidote to the torpedoboat, quickly assumed the *rôle* of those units they were created to annihilate, and the problem presented by boats of 400 to over 1000 tons attacking contemporary large ships was of a very different nature to that which constructors were called upon to face in torpedoboats rarely exceeding 100 tons in displacement. Then, too, the torpedo itself had advanced in precision and range beyond the wildest expectations of ten years

before, thus shortening for torpedo-craft the period during which, in an attack, they would be within the danger zone of gun fire.

This is one reason that led to the temporary abolition of the secondary armament in British ships; another was the increased range and flatter trajectory (therefore, enhanced effectiveness) of the main-armament guns, which, combined with improved methods of training and directing, suggested the probability of actions being fought at distances far too great for the effective use of small-caliber guns as auxiliaries to the larger weapons. But the battleship still required *offensive* protection from the torpedo—the new idea in this country was for some time centered in the ocean-going destroyers, which have, in recent years, been added to our Navy in considerable numbers; these were, by counter attacks, to take the place of the former secondary anti-torpedo-craft batteries, for which, by almost general acceptance, the 4-in. guns now mounted form a most inadequate substitute.

That the reasoning followed here did not meet with universal acceptance is plain from the recent designs of the German, Japanese, Italian, Austrian, and other admiralities; possibly our reversion to the 6-in. gun in our latest ships is a tacit if belated recognition of error in judgment. It would certainly be a retrogression to return to the days of half-a-dozen calibers; the combination in a single hull of every graduation of naval weapon was a fault the admission of which came curiously late and then, to the thinking of many, swung the pendulum of correction too far in the other direction. The doom of the old idea of mixed calibers found its genesis in the acceptance of this axiom—that one shell that *hits* is worth any number that *miss*. Hitting can be obtained only by “precision” in training, combined with scientific “observation” of the projectile’s flight and the “spotting” of its eventual destination.

#### EFFECTIVENESS OF INDIVIDUAL CALIBERS

The simultaneous discharge of a dozen different sizes of shell at the self-same mark gave those charged with observation but a feeble chance of judging the effectiveness of individual calibers; therefore, the “effect” of a broad-side must be accepted as a much more important factor than the “quantity” of metal fired. A ship, bristling with 9.2-in. guns, would possibly fire more actual weight per minute than could the number of 12-in. guns capable of being mounted on a similar displacement, but reports of resultant “effect” would be valueless owing to their confusion, whilst the lighter projectiles would lack the smashing power of the larger shells, a feature so essential in value of attack. The deductions following such considerations were recognized in several countries at about the same time. In the completion of the *Dreadnought* we led the way in practical demonstration of the new idea, yet General Vittorio Cuniberti in Italy, Sigfrido Popper in Austria, and eminent designers in the United States, Germany, and Japan all made suggestions during the early years of the present century pointing towards the adoption of a ship-type mounting a single caliber for battle purposes.

In their earliest designs contemporaneous with our *Dreadnought*, the French and Japanese did not, it is true, go all the way with us; yet their *Danton* and *Satsuma* classes of capital ship may not unfairly be regarded in the same intermediate relation to the single-caliber design as stand the *Lord Nelson* and her sister. In the United States, Italy, Germany, Austria, and here (with several minor nations whose action smacks more of imitation than of initiation or conviction) the conversion was complete, and in their initial

types their single-caliber ships all fulfilled to a greater or lesser extent the dictum enunciated by Lord Fisher of Kilverstone relative to battleship armament, "the smallest biggest gun and the biggest smallest gun."

Before giving detailed attention to the main armament thus developed and its influence on defense, speed, and other desiderata, it were well to recall that, though considerable unity of thought in principle (if not in detail) was evidenced, there existed a wide divergence of opinion as to what caliber of gun should be retained in addition to the main weapons for protection against boats armed with the torpedo. As an auxiliary for battle purposes the secondary battery had and has gone, and, with it, multiplicity of caliber and resultant complexities in time of action; but the necessity for an anti-torpedo craft armament, owing to the development of mosquito flotillas, had increased.

In the case of the United States and British ships the weapons provided—that is, the 3-in. quick-firer, seemed more of a "man-killing" battery; in the German, Japanese, Austrian, and other designs it might be termed a "boat-stopping" battery. Where one gained in rapidity of discharge the other gained in weight of projectile fired. For us the 4-in. gun has recently, up to the *Iron Duke* class, sufficed—one argument against a rise in size, put forward by Mr. McKenna when First Lord of the Admiralty, was that the change from a 4-in. caliber to a 6-in. caliber would add 2000 tons to the displacement of the vessels then under discussion.

Such a reason is not likely to weigh either with the naval architect or the naval officer, both of whom have only one desire, namely, to obtain the finest and most efficient unit that it is possible to devise for the purpose of maritime warfare. Whatever the reasons were that influenced the over-long retention of the lower caliber, the adoption of the 6-in. weapon now adds yet further to the singleness of design at home and abroad, which will be emphasized yet more when we deal with the heavy guns.

#### MAIN ARMAMENT

The numerical augmentation of the main armament may be traced in its inception to a variety of causes. First we find, as already noted, the natural tendency to progress in all directions in the matter of secondary armaments, leading to a stage where the distinctions between the main and subsidiary guns are almost lost. Next come considerations of defense and the realization that though, given sufficient thickness, armor can always beat the gun, it may be at the expense of initial outlay in construction owing to necessarily higher tonnage. A third point—here we enter once again the realms of controversy—was the acceptance of the turbine system of propulsion as being superior to the reciprocating engine and the natural desire not to lose the superlative advantages of speed offered to the nation that first courageously accepted the tenets of the new era. Speed is not by any means wholly the outcome of power—it is also due to a close study of ship form. The correlative value of these many considerations—and there were others—led to this conclusion: that persistence in a set design had produced, in the later years of the last century, stagnation in development, and the proper forward move would savor less of revolution than of catching up ground already lost. The deductions arrived at might, perhaps, be summarized as under:—

(1) The *raison d'être* of a battleship being to annihilate and not merely to injure, the value of a secondary battery as auxiliary to the large guns had disappeared.

(2) The acceptance of this tendency to increase in big gun caliber, weight of shell, muzzle velocity, and striking energy, an increased ratio of defense was essential to maintain battle-worthiness.

(3) The necessity of a greater weight of armor, of concentration of force in the main guns (probably in the direction of increased numbers as well as increased caliber) required higher displacements.

(4) The proper disposition of a large number of main guns, to avoid "interference," called for increased length.

(5) The practicability of turbine propulsion for the mightiest units suggested, in its sensible application, an advance in the hitherto accepted standard in battleship speed.

With these five requirements as a ground-work, five main designs (there may have been others) are known to have been evolved:—

(A) The *Dreadnought* in Great Britain.

(B) The *Satsuma* in Japan.

(C) The *Michigan* in the United States.

(D) The German Admiralty design, subsequently abandoned for the *Nassau* class.

(E) The forecasts of General Cuniberti in Italy.

In each case a hesitancy to go the whole way was clearly evidenced; it is easy to be wise after the event, but it is fair to assume that with even a single year more of study of the problems, each design set up would have led to their abandonment as not fitted to the practical needs of the time. Thus, in (A), the claims of the anti-torpedo-craft armament were almost entirely ignored; in (B) the desire not to abandon old ideas too quickly is easily apparent; whilst (C), with the fault of (A) strongly present, retained (as did all from (B) to (E)) the disadvantages of a relatively obsolescent mode of propulsion. (D) and (E) never materialized and for exactly opposite reasons. The German design was out-distanced at its inception, the Italian suggestion leapt ahead of invention and progress, and therefore remains a striking testimony to the prophetic genius of its author. A little national pride may be pardoned me if I submit that, of the five, the *Dreadnought* was undoubtedly the most practicable compromise of them all.

In the following table no attempt is made to give detail; the particulars are only for the purpose of outlining "type."

	(A)	(B)	(C)	(D)	(E)*
Displacement	17,900 tons	19,350 tons	16,000 tons	16,500 tons	17,000 tons
Engines.....	Turbine	Recipro- cating	Recipro- cating	Recipro- cating	Recipro- cating
Designed Speed	21 knots	20 knots	18½ knots	18 knots	24 knots
Belt Maximum	11 in.	9 in.	11 in.	11 in.	12 in.
Main Guns	10 12-in.	4 12-in. 10 10-in.	8 12-in.	6 11-in.	12 12-in.
Anti-Torpedo- Craft Armament	— 27 3-in. Q.†	12 6-in. Q. 12 smaller Q.	— 22 3-in. Q.	12 6.7-in. Q. 20 3.4-in. Q.	— 12 3-in. Q.

With the acceptance of these ideas as formulating "type" came this further consideration—how best to utilize the value of each gun carried?

Cuniberti's ship, despite her numerically superior armament, would,

\* Jane's "Fighting Ships."

† Original Armament.



owing to its disposition, have been identical in broadside fire both to (A) and (C); of her 12 guns four were masked on each broadside, and of the *Dreadnought's* ten weapons two were masked.

This introduced an old problem in a new form: was it better to have in this wise a certain percentage of the larger armament in reserve, or, by a centerline or a center-line-plus-echelon disposition, to give full broadside value to a lesser number of guns and utilize in other directions the weight saved by their reduction? In considering this phase of the subject, there are two main points calling for special attention—(1) the size of the guns, and (2) their disposition. The second of these is regulated (*a*) by the total number carried, and, to a lesser extent, (*b*) by the number that can be mounted on a single gun-emplacement. Although the number of guns capable of effective control has not definitely been determined (it varies in ships built or building from eight to fourteen), their disposition is reaching temporary finality in every country,—that is, along the center line.

The dispositions followed by certain nations may usefully be detailed:—

(1) Great Britain.—*Dreadnought*, *Bellerophon*, and *St. Vincent* classes, ten guns paired in five turrets; three on center line and one on either beam.

*Neptune* class, ten guns paired in five turrets; three on center line and two echeloned. *Orion*, *King George V*, and *Iron Duke* classes, ten guns of increased caliber, paired in five turrets on the center line.

*Queen Elizabeth* class, eight guns of further increased caliber, paired on the center line.

(2) Austria.—*Viribus Unitis* class, twelve guns in four triple turrets on the center line.

(3) France.—*Danton* class, four large guns paired on center line, and twelve lesser guns paired six on each broadside.

*Jean Bart* class, twelve large guns paired in six turrets; four, fore and aft, on the center line, and one on each beam.

*Provence* class, ten large guns paired in five turrets on the center line.

*Languedoc* class, twelve large guns in three quadruple turrets.

(4) Germany.—*Nassau* and *Ostfriesland* classes, twelve guns paired in six turrets; two, fore and aft, on center line, and two on each beam.

*Kaiser* class, ten guns paired in five turrets, three on center line, and two echeloned.

*E. Weissenburg* class, ten guns paired in five turrets on the center line.

(5) Italy.—*Dante Alighieri*, twelve large guns in four triple turrets on the center line.

*Conte di Cavour* class, thirteen large guns in three triple and two double turrets on the center line.

(6) Japan.—*Aki* class, four large guns paired on center line, and twelve lesser guns paired six on each broadside.

*Fuso* class, eight (or ten) large guns paired on the center line.

(7) Russia.—*Sevastopol* class, twelve guns mounted in triple turrets on the center line.

(8) U.S.A.—*Michigan* class, eight guns, paired in four turrets on the center line.

*Delaware* and *Utah* classes, ten guns paired in five turrets on the center line.

*Wyoming* class, twelve guns paired in six turrets on the center line.

*Texas* and *Nevada* classes, ten guns of increased caliber, paired in five turrets on the center line in *Texas*, in two triple and two double turrets in *Nevada*.

SINGLE-CALIBRE MAIN ARMAMENT ERA																		
GREAT BRITAIN	AUSTRIA	FRANCE	GERMANY	ITALY	JAPAN	RUSSIA	U. S. AMERICA	1882-4	1912-4									
INTERMEDIATE PHASE																		
1 <sup>ST</sup> STAGE																		
2 <sup>ND</sup> STAGE																		
3 <sup>RD</sup> STAGE																		
4 <sup>TH</sup> STAGE																		
REPRESENTATIVE PRE-DREADNOUGHT TYPE																		
FORBES (1882-1902)	E. KARL (1902)	REPUBLIQUE (1902)	BRUNSWICK (1902)	B. BRIN (1902)	NIKASA (1902)	CZAREVITCH (1902)	MAINE (1902)											
LORD NELSON (1904)	RADETZKI (1904)	DANTON (1904)			AM (1904)	A. PEROVSKY (1904)	LOUISIANA (1904)											
DREADNOUGHT (1906)																		
NEPTUNE (1908)																		
ORION (1910)																		
QUEEN ELIZABETH (1912)																		
PROVENCE (1913)																		
KAISER (1913)																		
CONTE DI CAPOV (1913)																		
E. WEISSBURG (1913)																		
DANDALO (1914)																		
FUSO (1914)																		
NEVADA (1915)																		
TEXAS (1912)																		
DELAWARE (1908)																		
SEVASTOPOL (1911)																		
KAWACHI (1910)																		
DANTE ALIGIERI (1912)																		
OSTRIESLAND (1908)																		
JEAN BART (1911)																		
VIRIBUS UNITIS (1911)																		
PROVENCE (1913)																		
KAISER (1913)																		
CONTE DI CAPOV (1913)																		
E. WEISSBURG (1913)																		
DANDALO (1914)																		
FUSO (1914)																		
NEVADA (1915)																		

TABLE ILLUSTRATING MAIN ARMAMENT DISPOSITION IN BATTLESHIPS OF THE EIGHT CHIEF NAVAL POWERS 1279

Notes:—Dates of launch are given in brackets under the names of type. The plans between the stages of development indicate vessels of an intermediate type. Except in the first column, the main armament only is shown



*Pennsylvania*, twelve guns, as above, paired in six turrets on the center line, or in four triple turrets.

EFFICIENCY OF CENTER LINE DISPOSITION

The conclusion arrived at is, that the center line disposition by general consent, presents the most efficient combination; certainly it has removed many structural disadvantages found in the echelon principle, and permitted a more effective placing of the anti-torpedo-craft batteries. So far, then, we find agreement. Yet a new complication was already in existence as the outcome of the appearance of the battle-cruiser. It is a truism to remark that the development of one class of ship tends not infrequently to its incorporation in quite another class. The torpedoboat of to-day is larger, faster, and better armed than many a destroyer still in service; the destroyer in its largest form (*Swift*, 2170 tons; *Almirante Condell*, 1430 tons; *Umikaze*, 1150 tons; *Novik*, 1260 tons) exceeds in displacement, and even more in battle value, former scouts or cruisers.

It was the differences of opinion as to the most effective application of such armor as their tonnage permitted that led to the building, side by side, of the "protected" and the "armored" cruiser, in the meaning of these terms accepted prior to the new official classification.

TABLE ILLUSTRATING MAIN ARMAMENT DISPOSITION IN BATTLE-CRUISERS










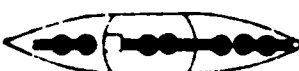




 INVINCIBLE (1907) BRITISH 8-12 in.	 INDEFATIGABLE (1909) BRITISH 8-12 in.	 LION (1910) BRITISH 8-12-5 in.	 TIGER (1913) BRITISH 8-12-5 in.
 VON DER TANN (1908) GERMAN 8-11 in.	 MOLTKE (1910) GERMAN 10-11 in.	 E. K. AUGUSTA (1910) GERMAN 8-12-5 in.	 KONGO (1912) JAPANESE 8-14 in.

TABLE ILLUSTRATING MAIN ARMAMENT DISPOSITION IN BATTLESHIPS OF LESSER POWERS.

 MINAS GERAES (1908) BRAZILIAN 12-12 in.	 RIO DE JANEIRO (1912) BRAZILIAN 14-12 in.	 MORENO (1911) ARGENTINE 12-12 in.	 A. LATORRE (1912) CHILEAN 10-14 in.
 ESPAÑA (1913) SPANISH 8-12 in.	 RESNAO V (1914) TURKISH 10-12-5 in.		

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The two types rapidly diverged until it became a farce to include, say, the *Defense* in the same category as the *Amphion*. The armored cruiser attained the zenith of its reputation at Tsushima, where the Second Division, under Vice-Admiral Kamimura, deliberately played a prearranged part in that fleet action. A new classification seemed necessary—for myself, I have always drawn the main distinction as between ships "capable of lying-in-line," and "the rest." This permits of different application to individual navies where the problems of supposititious war are varying factors, and it recognizes at the same time the almost constant acceptance of value in a "fast battle wing."

The outcome, in its "all-big-gun" form, first found practice in the *Invincible* type, yet they were, and are, as natural a sequence (except in the breaking away from obsolescent ideals) of the *Defense* and her sisters as is the *Dreadnought* of the *Lord Nelson*. From those possessing a doubt on this

point, I would ask a classification of such ships as the Japanese *Tsukuba*, the Italian *Pisa* and the German *Bluecher*, and the reasons for their decision; it provides a controversy incapable, I believe, of satisfactory or definite settlement.

The *Invincible* type was to the *Dreadnought* that which the armored cruiser had always been to the battleship—a vessel possessing a few knots more speed at the expense of defense and offense. The fighting power asked of ships being governed in design by that of potential enemies, it was but natural that Germany (the only other nation following our lead until Japan commenced her four *Kongo* class) should suppress the 11-in. gun in favor of one of larger caliber. Our counter-blast to the *Seydlitz* is already in service—the *Lion* type; but observe the result of this competition. From the *Dreadnought* to the *King George V* we have risen in displacement from 17,900 tons designed to 23,000 odd—say, 5500 tons increase; from the *Invincible* to the *Queen Mary* we have risen from 17,250 tons (designed) to 27,000 tons, or nearly 10,000 tons!

#### SPEED CONSIDERATIONS

The cost per ton works out relatively at the same price; but with a higher total cost, the actual fighting value of the battle-cruiser is both in offense and defense much below that of the battleship. Speed is a valuable tactical asset, but it may obviously be bought too dearly in any given era of progress in construction; work out the cost per pound of broadside of the *King George V* (14,000 lbs.), and that of the *Queen Mary* (11,200 lbs.), and remember the 2½ in. advantage in maximum belt-thickness of the first named, and then put this question: does a superiority of six knots (designed speed) outweigh the losses thus shown? Then, too, the adoption of a gun caliber beyond the 13.5 in. and 14 in. has quite as much negatived the value of the belt thickness of the *Queen Mary* as did the advent of the 13.5 in. and 14 in. the belt thickness of the *Invincible*. Speed demands fine lines—armor demands adequate buoyancy and ample beam; with every increase in weight of armor to retain (much more to augment) speeds, the length requires extending out of all proportion to the fighting value acquired; even if this were combated as a proposition, the difference in cost between the battle-cruiser and her slower mate would widen until the saving in dropping the one type might provide for an advantageous numerical increase in the other.

#### FUSION OF BATTLESHIP AND BATTLE-CRUISER

This is not to suggest that an error has been made in promoting the battle-cruiser; up to its present stage a survey of those built and building must lead to conclusions wholly favorable to the greatest naval power. A rich nation can afford luxuries; we have them *in excelsis* in our ten battle-cruisers, and should continue their development if the latest phase in design does not check those other nationalities building or possessing the type. What is this latest phase? It is the outcome, not merely of arguments such as those set out above, but also of a desire evinced on every hand to simplify fleets by a reduction in the number of ship classes included; this argument is a very practical one, and would find perfection in the acceptance of three types as the be-all and end-all of fleet necessities: (a) the battleship, (b) the cruiser, (c) the torpedo vessel.

It is not part of my duty to raise to-day so complicated and controversial a matter, but naval design in capital-ships in two countries at least is moving towards a fusion of the battleship and battle-cruiser. Everything in this connection is relative, and because the speed of these latest vessels is to be equal to that for which the *Invincible* class was designed, they will no more be derivatives of the battle-cruiser than is the *Lion* (because she carries a broadside of eight big guns) a derivative of the *Dreadnought* (with a numerically equal beam fire). The answer lies, on all counts, half-way, and the *Queen Elizabeth* class and the Italian *Dandolo*s are inaugurating in their conception a move quite as revolutionary in its probable results as that which was made when the *Dreadnought* was laid down. In effect, they comprise in a single unit the powers delegated to two units in the past, (a) they will be able to catch up any other battle fleet built or building, thanks to a speed of 25 knots, (b) they will mount an armament comparable in number and power to that carried by any contemporary types, permitting annihilation of the enemy when caught, and (c) they will be able to face any fire, which ships at present afloat or under construction can offer, owing to a thickness of belt exceeding that yet applied (although this is not quite true of the *Dandolo*s).

Admiral Sir Reginald Custance in his recent admirable work ("The Ship-of-the-Line in Battle") laid it down that "the main object in battle is to make the enemy believe that he is beaten. The most effective way to do this is to disable his personnel and silence his guns. I submit that an even more effective method is at the very outset of an action absolutely to shatter and destroy a part of his matériel. Criticism of the deductions and conclusions which I have ventured to set forth here must largely turn on the acceptance of one or other of these dicta; yet this much may be laid down with absolute definiteness—that the general principle of ship design is rapidly completing a full cycle in the steady movement towards armament comprising a lesser number of the heaviest weapon effective for present-day battle purposes. If history may be held to prove anything, or be regarded as in any way a guide to future development in design, then we must look to a recommencement of the vicious circle involving all the old variations of change in guns, armor and speed, with their multifarious complexities and their proneness to reintroduce fleet heterogeneity. All this with but one definite result for prophecy—an ever-increasing displacement and an ever-mounting cost.

—*Page's Weekly*.



### AN IMPROVED FORM OF PROJECTILE

The projectile described in this patent\* has a telescopic tail which, when closed, forms a practically flat base to the shell. When extended, as illustrated, it prevents the formation of the vacuum, which, as is well-known, impedes the flight of a projectile of ordinary shape. The various sections of the tail are provided inside with annular grooves into which gases are caused to expand to facilitate the extending process of the tail.

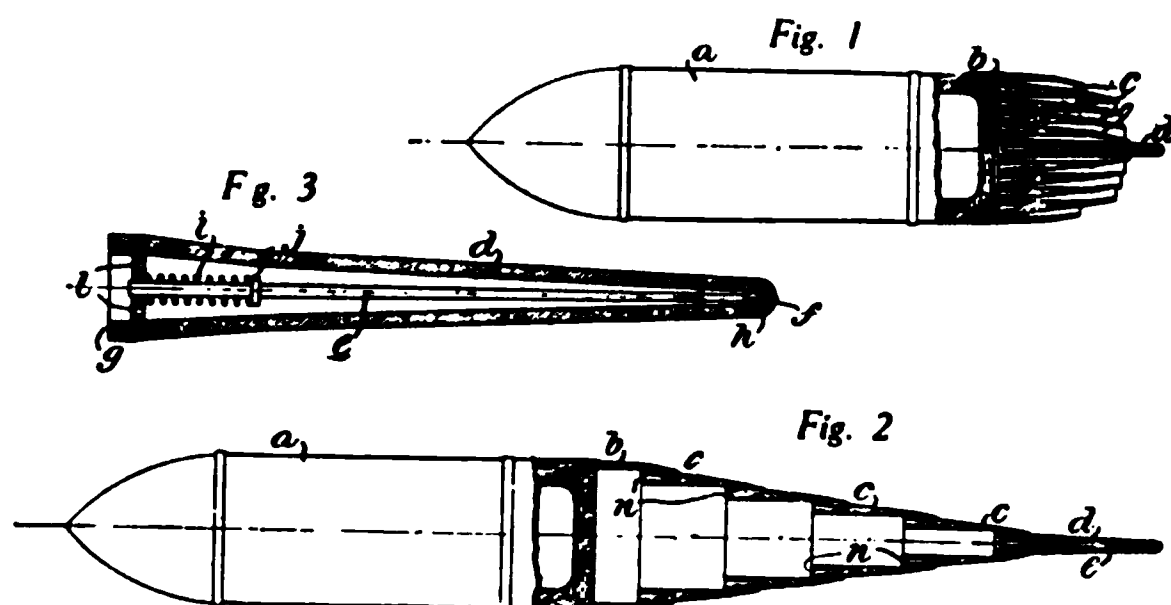
Fig. 1 is a side elevation, partly in section, of the projectile shut up before firing. Fig. 2 is a view of the projectile corresponding to that shown in Fig. 1,

\* British patent 10,325 (1912). Lieut. B. Svistounoff, Saint Petersburg. Accepted December 5, 1912.

but in the expanded position after firing. Fig. 3 is a section of the rear cone of the projectile on an enlarged scale. To the solid body *a* of the projectile the ring *b* is attached. The latter encloses the series of gradually decreasing telescopically arranged conical rings *c*. To the last of these conical sections the tail proper *d* is attached.

The front portion of this tail is wider than the rear and within it is arranged the spindle *e* which passes into the opening *f* at the one end, and into the cup-shaped part *g* at the other. The opening *f* is of conical shape and the end of the spindle has a corresponding conical shaped part *h*, which in the normal position is caused, by the spring *i*, to close the opening. The spring *i* is confined between the under part of the cup *g* and the collar *j* on the spindle. The tray *g* is provided with openings *l* through which gases are allowed to pass into the tail cones. The conical rings *o* are loosely inserted into each other, and when closed they occupy the position which is illustrated in Fig. 1. When pulled out the front portion of each cone engages tightly with the necked end of the cone in front of it. The complete outer shape of the projectile with the tail extended approximates as will be seen to that of a cigar.

The projectile is placed in the cartridge with its tail in the folded condition. When the gun is fired the gases of combustion pass through the



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opening *f* and force the conical spindle forward against the pressure of the spring *i*. As the projectile moves up the bore and the pressure of the gases subsides, the spring *i* regains control and forcing the spindle *e* backwards once again closes the passage *f*. The pressure of the gases which have passed into the tail, however, is great enough, acting through the tray *g*, to propel the various sections of the tail into the position illustrated in Fig. 3. They are helped in this work by the extra area that is created by the annular grooves *n* in the tops of each cone section. The inertia of the conical parts themselves contributes to the desired result.

The patentee says, "Projectiles according to this invention can be utilized not only for shooting from ordnance of various calibers, but also from rifles, and although the greatest advantages would be obtained in shooting with smooth bore guns (as the deviation would be done away with), the said projectiles could also be used for shooting with rifled guns or rifles, for which purpose it is merely necessary to provide corresponding guide rings."

—*Arms and Explosives.*

## THE AUSTRIAN 12-INCH MORTAR AND 4-INCH SIEGE GUN

In Austria, during 1912, were constructed two pieces of fortress artillery of which the equals can scarcely be found in foreign services—not only in point of penetration, range, and strength, but also in point of control in direction and elevation, the control being due to the most modern traversing mechanism and elevating gear.

It will probably be of interest, even to foreign readers, to follow the *Danzers Armee Zeitung's* account of the main facts of the construction of these new types of ordnance—at least, in so far as those facts are now known.

In order that what follows may be better understood, a few words will first be said relative to the military value of the new product and the causes that led to it.

The Austro-Hungarian fortress artillery has included since 1898 a 9.5-inch, steel, siege mortar which at that time excelled in power and accuracy all similar pieces of other services and which to-day still claims first rank.

However, the projectile of that mortar could not be depended upon to breach without fail the thick revetments of modern permanent fortifications. Salvo fire was necessary; that is to say, the pieces had to be organized in four-gun batteries. Hence the introduction of the new mortar: its power at 10,000 yards being equal to that of a battery of the less powerful pieces, the number of guns in a battery is reduced to two. This new creation is known as the 12-inch mortar M 11. The length of the piece, which is of steel, is 14.1 feet; the powder charge is upwards of 26 pounds; and the projectile, of steel, weighs 860 [?] pounds. The elevating gear is independent of the movement of the mortar. The extreme range is 10,500 yards, and the maximum ordinate of the trajectory 4375 yards.

The accuracy of the mortar is remarkable: fifty per cent of the shots fired fall in a space of which the longer axis is about 55 yards, depending upon the range and the strength of the charge. The rapidity of fire is, in general, ten shots per hour. The elevation varies from 45° to 70°; the movement in azimuth is 120°, with platform, and 60° without.

The piece is transported by automobile; each battery of two mortars, with its first supply of ammunition, includes three automobiles with four tons. The automobile engines are of 100 horsepower and 800 revolutions. Going into battery requires about an hour. The weight of the piece itself is seven tons, the weight of the carriage ten tons, and of the platform nearly seven tons.

This mortar is already partially in the hands of the artillerymen; but such is not the case with the other new ordnance type, a siege gun, the study and tests of which are still in progress. The siege guns which we have had up to this time, 4.72-inch and 6-inch, date back to 1880, and are no longer suitable, being out of date as regards mobility, penetration, range, and rapidity of fire. Hence the necessity for better; and the problem has been very satisfactorily solved through the introduction of a 11-inch steel siege gun. It is a rapid fire gun with recoil mounting; it has rear shields, and it is employed without a platform. Its length is about 11.8 feet. The projectile weighs 38.5 pounds; and the shrapnel contains some 700 bullets of hard lead, of individual weight of 9 grammes; the time adjustment is easily made by hand, and the maximum range of the shrapnel employing time fuze is 13,670 yards.

The transporting of this gun requires two six-horse carriages; its going into battery takes scarcely ten minutes.—*Revue Militaire Suisse*.

The recent test firing of the new 12-inch mortars is said to have been favorable. At a range of 8750 yards, 151 shots were fired at a granitic concrete target 19.7 yards wide and 9.8 yards long. There were 90 hits on the target in all, of which 21 were direct hits, the remainder being hits by shell fragments. The detonation of the 1320 (?) lb. trinitrotoluol shell, amongst other things, destroyed a block of concrete 1.64 yards thick, and perforated a 6-inch armored turret. Thirty-four mortars to be propelled by Daimler automobiles of 100 h.p. have been ordered. Firings against armor plate will take place at an early date.

Their results apparently are not sufficiently effective, for it is stated a heavier piece, a 16.5-inch mortar, which is probably designed for the coast, and of which two test pieces have already been delivered, will be experimented with. As the maximum range is about 15,300 yards, the proof firing will not be held in Felixdorf, but on the new large proving grounds at Hajmaske. The weight of the projectile is said to be about 2200 lbs.

—*Deutsches Offizierblatt*.\*



#### THE POLTE VARIABLE-CHARGE CARTRIDGE

The advance from slow fire to rapid fire—an advance made possible for field guns by the employment of recoil carriages and fixed ammunition—could not, of course, be limited to flat trajectory pieces, so curved fire pieces,

in their turn, are now experiencing a like evolution. But while it is simple enough to apply to howitzers the principle of the long-recoil carriage, the adoption of fixed ammunition for them is rendered difficult by the necessity,

\* Through the courtesy of the War College Division, General Staff, translated for the JOURNAL by Lieutenant Donald Armstrong, Coast Artillery Corps.

in their case, for variable charges. A German engineer, M. E. Polte, has solved the difficulty in the following original manner:

The cartridge case *d* is fixed to the projectile; but a portion of the charge is enclosed in a sort of spiral *b*, made of easily combustible stuff (probably explosive itself), one end of which, after passing through the cylinder *l* abuts against the primer *p*. Contractions *e* divide the spiral into sections, each of which is marked with a number.

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From the various reports of the instrument, which are all rather indefinite, we cull a few facts.

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*Fifty* shots were thus fired at 10,000 yards range while rolling over five degrees—actual average roll was a total of thirteen degrees, six one side to seven the other—and there were found on the target *forty-one* direct hits, or 82 per cent. The best previous records were the *Thunderer's* first off Berehaven of thirty-seven hits out of fifty, or 74 per cent, and the *Orion's* twenty-four hits out of thirty, or 80 per cent, but at 6500 yards only, made in May.

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A German paper commenting on this apparatus states that the principle is not new and that their service, as well as the French, had already applied the system to their seacoast batteries, and cannot believe that on shipboard



The recent test firing of the new 12-inch mortars is said to have been favorable. At a range of 8750 yards, 151 shots were fired at a granitic concrete target 19.7 yards wide and 9.8 yards long. There were 90 hits on the target in all, of which 21 were direct hits, the remainder being hits by shell fragments. The detonation of the 1320 [?] lb. trinitrotoluol shell, amongst other things, destroyed a block of concrete 1.64 yards thick, and perforated a 6-inch armored turret. Thirty-four mortars to be propelled by Daimler automobiles of 100 h.p. have been ordered. Firings against armor plate will take place at an early date.

Their results apparently are not sufficiently effective, for it is stated a heavier piece, a 16.5-inch mortar, which is probably designed for the coast, and of which two test pieces have already been delivered, will be experimented with. As the maximum range is about 15,300 yards, the proof firing will not be held in Felixdorf, but on the new large proving grounds at Hajmaske. The weight of the projectile is said to be about 2200 lbs.

—*Deutsches Offizierblatt*.\*



#### THE POLTE VARIABLE-CHARGE CARTRIDGE

The advance from slow fire to rapid fire—an advance made possible for field guns by the employment of recoil carriages and fixed ammunition—could not, of course, be limited to flat trajectory pieces, so curved fire pieces,

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"In general, it is fundamentally wrong, if as the English now appear to do, one places his hopes all too much on a presumptive advantage in the perfection of the technical aids, so easily injured in battle.

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### BRITISH NAVAL GUNNERY

It is a significant fact that in the returns issued this week by the Admiralty giving the results of tests of gun-layers in the Fleet for the past year there is no reference to the time element. Formerly the number of hits per minute by the twin-gun turrets of capital ships and by guns in the case of smaller caliber weapons was an important, if not the determining, standard of efficiency. But now the factor indicative of excellence is the percentage of hits to rounds fired. Is this a consequence of the new system of gun-control under which salvo firing is preferred to independent fire and central gun-laying to aiming being the individual work of the captain of the turret or of the gun team? The difference is one of significance whether regard be had to the much-debated question as to whether the function is to disarm or to destroy the enemy, although it must be admitted that the latter is much more likely to be achieved by a well-directed full broadside rather than by a rain of shots independently fired. With the increase in caliber of guns, the consequent additional weight of ammunition for a given number of rounds, and the resultant limited duration of an engagement, the efficiency of each shot has had to be most carefully considered, and consequently central gun-laying has won the day.

In analyzing the results of the past year's work, the chief consideration must be the percentage of hits to the number of rounds fired. The 13.5-in. gun comes into the return for the first time, four ships having used this weapon in battle practice—the *Orion*, *Lion*, *Monarch*, and *Thunderer*—and the percentage in the case of these ships, according to the order given, is about 68, 65, 53, and 47½, the average for the 126 rounds fired being 58.

As these ships are our latest, and as on such largely depend success in war, it is gratifying to know that this is the best average result for any of the large caliber guns. In the case of the 12-in. gun fitted to the vessels of the *King Edward VII* and subsequent classes—twenty-four in all, including the earlier dreadnought battleships and cruisers—the average for 607 rounds is 55.02 per cent of hits to rounds fired, as compared with 37.3 and 48.9 per cent in the two preceding years. The best result—that of the *Superb*—is 86 per cent, a splendid result, and the worst 40 per cent, which is better than the average of 1911. The results with the older type of 12-in. guns is 35.5 per cent, about the same as in the previous year, but 3.2 better than in 1910.

It is creditable to the designers and manufacturers of guns, gun-mountings, sights, and other mechanism conducive to good practice that in most cases the newer weapons give better results than the older. The latest 6-in. breechloader comes out at 50 per cent, the quick-firer of the same caliber at 63.6, and the 4-in. gun at 38.5 per cent. These are more numerous than the bigger weapons, and the higher achievements are no doubt more largely discounted by the greater number of mediocre results, where 6, 4, and even 0 per cent of hits are recorded. Better practice seems to be made by the lighter weapons in large ships. Thus the 12-pounder 18-cwt. gun has an average of 60.5 per cent, as compared with 55.6 per cent in the previous year. In the case of the 12-pounder 12-cwt. gun the results were 41.7 per cent in 1910, 41.6 per cent in 1911, and 68.9 per cent in 1912. The 64.4 per cent for the 6-pounder and 3-pounder guns is more than double the ratio in each of the two preceding years; while the 3-pounder Vickers has advanced from 41.8 per cent in 1911 to 78.2 per cent of hits in 1912. As many as 1999 rounds were fired by the last-named gun, and of these 1560 were hits. It should be remembered, also, that in all cases the firing was at high speed at long, yet unknown, ranges; that the target was only a fraction of the area of a modern ship's silhouette; and that in the case of large guns the work of 115 ships, and of smaller guns the practice of 99 ships, are included.

As to the tests with torpedo craft, 198 torpedoboat destroyers, or torpedo-boats, carried out the year's practice, and these fired 871 rounds from guns of 4-in. or less caliber. Forty seconds were allowed for scoring, and, on an average, 48.94 per cent of hits to rounds fired were recorded, the result for the 4-in. breechloader being 51.59 per cent; for the 12-pounder 12-cwt. on the latest mountings, 57.7 per cent; for the 6-pounder, with telescope sights, 45.61 per cent. This same gun, without this accessory, only achieved 13.11 per cent.—*Engineering*.



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clusion that jamming of the case due to the occasional failure of a cartridge case to be forced into the chamber by the inclined portion of the breech block, and sticking of case in the chamber due to lack of care in resizing, are the most frequent causes of interruptions. The exercise of greater care in the preparation of ammunition for this gun, and in loading, are the only practicable means of eliminating interruptions.

*Loading trays for 5-inch gun, for 6-inch Armstrong gun, and 6-inch guns of all other models.*—Satisfactory designs of loading trays for the above guns have been developed and recommendation made for issue to service.

*Thin gas check pads.*—Sufficient firings have been made to demonstrate the superiority of the thin pads used in the later models of cannon over the thicker pads of the earlier cannon.

*Test of searchlight for examining bores of guns of 5-inch caliber and upwards.*—A satisfactory design has been developed and working drawings submitted.

#### FRANKFORD ARSENAL

*Test of caliber .30 ball cartridge.*—A test is in progress to determine the effect of marching combined with variations in heat and cold on the powder of the service caliber .30 ammunition. It is estimated that the cartridges have been subjected to approximately the equivalent of 1000 miles of infantry marching, with great variations in temperature. The tests show no appreciable effect on the powder.

#### ROCK ISLAND ARSENAL

*Chest for marking outfits.*—New chests for marking outfits for both metal and leather have been designed. These new chests are lighter and of less volume than the present models.

*Pack reel for telephone wire.*—The design of a pack reel for carrying telephone wire packed on a mule has been undertaken and certain suggestions by the Mountain Artillery have been incorporated.

*Top stick for aparejo.*—Experiments are being made with a view to developing a new top stick which will overcome the defects of the present model.

#### SANDY HOOK PROVING GROUND

*Ballistic test of 1000 Semple shell tracers (percussion type).*—Fifteen of these tracers attached to cast iron shot were fired from 3-inch (15-pounder) gun with service velocity and elevation of 5 degrees and 11 seconds. All tracers ignited immediately on leaving muzzle and continued to burn until impact of projectile on water. Lot passed the prescribed test.

#### WATERTOWN ARSENAL

*Manufacture.*—Two hundred 6-inch armor piercing shell, one hundred 12-inch deck piercing shell, 700 pounds, and one hundred 12-inch deck piercing shell, 1016 pounds.

#### WATERVLIET ARSENAL

*Manufacture.*—Five 1-pounder subcaliber guns for 3-inch field guns.

*Relining.*—Two 12-inch Navy guns with taper liners.



## NOMENCLATURE OF DECKS

A Navy Department order directs that the following nomenclature of decks shall be followed for United States naval vessels.

The highest deck extending from stem to stern shall be called the "main deck."

A partial deck above the main deck at the bow shall be called the "forecastle deck;" at the stern, "poop deck;" amidships, "upper deck."

The name "upper deck," instead of "forecastle deck" or "poop deck," shall be applied to a partial deck extending from the waist to either bow or stern.

A partial deck above the main, upper, forecastle, or poop deck, and not extending to the side of the ship, shall be called the "superstructure deck."

A complete deck below the main deck shall be called the "second deck." Where there are two or more complete decks below the main deck they shall be called the "second deck," "third deck," "fourth deck," etc.

A partial deck above the lowest complete deck and below the main deck shall be called the "half deck."

A partial deck below the lowest complete deck shall be called the "platform deck." Where there are two or more partial decks below the lowest complete deck the one immediately below the lowest complete deck shall be called the "first platform," the next shall be called the "second platform," and so on.

Decks which for protective purposes are fitted with plating of extra strength and thickness shall be further defined, for technical purposes, as "protective" and "splinter," in addition to their regular names. Where there is only one such deck it shall be defined as "protective," and where there are two, that having the thicker plating shall be defined as "protective," and that having the thinner plating shall be defined as "splinter," in addition to the regular names.

Where a protective deck is stepped a complete deck height the respective portions shall be distinguished by means of the terms "middle protective section" and "forward (or after) protective section," in addition to the regular names. Where a splinter deck is stepped a complete deck height, the respective portions shall be similarly distinguished.

Where a portion of the protective or splinter deck is sloped, the sloping portion shall be defined as the "inclined protective deck," or "inclined splinter deck."—*The Navy*.

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Short Notes

*H. M. Battle-Cruiser Princess Royal*.—The *Princess Royal* is 660 ft. in length, with a beam of 88½ ft. and a mean load draught of 28 ft. Her displacement is 26,350 tons, and turbines of 70,000 horse-power, manufactured also by Messrs. Vickers, were designed to give a speed of 28 knots. On her trials, however, the ship easily exceeded both horse-power and speed, and is stated, though unofficially, to have made no less than 31.7 knots during one period of her trials. This is equivalent to 39.96 miles an hour. No other armored vessel in the world has approached nearer than three knots to this, and only a very small number of destroyers have exceeded it.

The new cruiser is armed with eight 13.5-inch guns, mounted in four turrets on the center line. The second turret from forward is raised, so that its guns bear ahead; therefore four guns bear in this direction, two astern, and eight on either broadside. With a very small turn of the helm, however, the whole eight guns can be brought to bear on an enemy ahead. Sixteen 4-inch guns are mounted for defense against torpedo craft. The main armor belt is nine inches thick, and there is storage capacity of 3500 tons of coal and about 500 tons of oil fuel.—*United Service Gazette*.

*Japanese Battle-Cruiser Kongo*.—The *Kongo* was designed by Messrs. Vickers, and was laid down on January 17th, 1911, and launched on May 18th last year. She is 704 ft. long and 92 ft. in beam, her displacement at a draught of 27 ft. 6 in. being 27,500 tons. Her armament consists of eight 14-inch guns in four center-line turrets, and an antitorpedo battery of sixteen 6-in. guns. Protection is afforded by a belt of Krupp steel 10 in. thick amidships, tapering to 5 in. forward and 3 in. aft. The main gun barbettes are of 10 in. steel, and there is a protective deck 2½ in. thick. The contract speed is 28 knots with Parsons turbines of 70,000 h.p., and the maximum fuel capacity is 4000 tons.—*Page's Weekly*.

*The British Ships of the Queen Elizabeth Class*.—The dreadnought cruisers of the *Queen Elizabeth* class are advanced enough for their main points to be known with a fair degree of certainty. Their displacement will be about 27,000 tons, or 2000 more than the *Iron Duke* class; their engines, 60,000 h.p., are designed to give 25 knots, but it is hoped that 27 may be gotten out of them and that, in this respect, the ships may not be inferior to the dreadnought cruisers of the *Indomitable* class. Their belt armor will have a maximum thickness of 13.4 inches. Their main armament will consist of eight Vickers 15-inch, 96-ton guns, throwing a projectile of 1950 pounds instead of the 1400 pound projectile of the *Iron Duke* class. The secondary armament will be made up of sixteen 6-inch guns, arranged in redoubts whose walls in which are the gun ports are at angles to the axis of the ship, as was the case with the last dreadnought cruisers. The *Queen Elizabeth*, the *Warspite*, etc., are in reality dreadnought cruisers in which are combined in a single type the battleship and the battle-cruiser.—*Le Yacht* (Paris).

*Ships of the New British Program*.—In the ships of the new program, it is said, will be realized the combination of battleship and cruiser, following a plan already adopted by the Russian navy—Lord John Fisher's ideal. It is believed that their displacement will be about 28,500 tons (1000 more than the *Queen Elizabeth* class); that they will carry six 16-inch or 16¼-inch guns in three double turrets; that the belt armor will be 13 inches; and that their speed will be 25 knots, the speed of the new Russian *Ismail* class. They will also carry 3-inch guns, unprotected, capable of being fired vertically.—*Le Yacht* (Paris).

*New British Destroyer Shark*.—The *Shark* is one of twelve destroyers designed under the 1911-12 naval programme by Sir P. Watts, and will be the fourth of her class to be delivered from the builders, her sister destroyers

already in commission being the *Acasta*, *Cockatrice*, and *Christopher*. These vessels have all been built with a length of 260 ft. (20 ft. longer than the 27-knot destroyers built under the 1910-11 programme), and a displacement of 935 tons, and are fitted with turbines of 24,500 horse-power and equipped with three 4-inch breech-loading guns and two 21-inch torpedo tubes. The remaining eight destroyers of the 1911-12 programme are designed by private firms, and are estimated to steam at speeds varying from 29.5 knots to 31 knots.—*Page's Weekly*.

*English Submarines*.—The *E* class, now under construction, are 176 feet long, 23 feet wide, with a surface displacement approximating 800 tons. With 750 shaft horse-power they are expected to have a speed of 16 knots on the surface. The under-water motors of 600 horse-power should give these vessels a speed submerged of ten knots. They will carry four of the largest torpedo-tubes, but will not carry the 3-inch guns originally intended. There are four of this class all to be in service by the end of March, 1913.

The *F* class, *F 1* to *F 8*, will be of about 1200 tons displacement with a speed of 20 knots on the surface and 12 knots submerged.

—*United States Naval Institute Proceedings*.

*Submarine Innovations*.—The Americans have introduced one more novelty into the construction of torpedo craft. In this case it is the submarine that has received the attention of the genius of the constructors of the United States. A new vessel, the *Seal*, has been fitted with wheels for getting about on the bed of the ocean, or of rivers or harbor channels. These wheels have proved of great advantage in navigating channels, as was demonstrated in Russia, where an experimental submarine thus fitted was the only vessel that succeeded in getting near some breakwater fortifications that were being attacked, without being discovered by the defense. The *Seal* attained a surface speed of about 14.7 knots, which makes her the fastest vessel of her type in the United States Navy. She also steamed at about 11 knots when submerged, and but a few feet from the ground, and made a submerged voyage at 5 knots for over 125 knots. She is fitted to recharge her electrical batteries while running by means of one engine, while she can fire a Whitehead torpedo while submerged or on the surface, covering an arc of 300 degrees. In this latter she is unique among submarines, and also for being able to run 10 knots with one engine while the batteries are being charged with the other. She likewise established a world's record by being taken down 150 feet with her whole crew on board, which is a great accomplishment. The vessel is, therefore, of a very handy and formidable type, with the most up-to-date improvements of her class, and she has many sisters building, embracing innovations that will probably attract attention and imitation in this country.—*United Service Gazette*.

*New Designations for British Cruisers*.—The Admiralty announces it has been decided to discontinue the use of the terms armored cruiser, protected cruiser first-class, protected cruiser second-class, protected cruiser third-class, unarmored cruiser, and scout. In future cruisers will be officially divided into three classes, namely, battle-cruisers, cruisers and light cruisers.

The term battle-cruiser will continue to be used as at present, the term cruiser will be used to designate all vessels at present classified as armored cruisers and protected cruisers first-class, and the term light cruiser will be used to designate the remaining cruisers and vessels hitherto classified as scouts.

—*United States Naval Institute Proceedings.*

*New Classification of Japanese Ships.*—At the commencement of September the new classification of the ships of war of the Japanese Navy was published. The classification is as follows:—

- (1) Battleships (*sen kan*).
- (2) Battle-cruisers (*fun yo sen kan*).
- (3) First-Class Cruisers (*itto jun yo kan*), more than 7000 tons.
- (4) Second-Class Cruisers (*nito jun yo kan*), less than 7000 tons.
- (5) First-Class Coast Defense Vessels (*itto kai bo kan*), more than 7000 tons.
- (6) Second-Class Coast Defense Vessels (*nito kai bo kan*), less than 7000 tons.
- (7) First-Class Gunboats (*itto ho kan*), more than 800 tons.
- (8) Second-Class Gunboats (*nito ho kan*), less than 800 tons.
- (9) Destroyers (*ku ckiku kan*), first-class—more than 1000 tons; second-class—1000 to 600 tons; third-class—less than 600 tons.
- (10) Torpedo-boats (*sui vai tet*), first-class—more than 120 tons; second-class—less than 120 tons.
- (11) Submarines (*sen sui tet*).

—*Journal of the Royal United Service Institution.*

*Aeroplanes in Coast Warfare.*—They can be carried, stowed, and used by all large ships:

- (1) To reconnoiter an enemy's port or to search out his advanced bases and to assist in the operations of a blockaded or of a blockading force.
- (2) To locate and destroy submarine mines, submarines, and dirigibles, and to assist in the operations of submarines and torpedoboats.
- (3) To damage an enemy's docks, magazines, ships in repair or under construction, dirigible sheds, and other resources.
- (4) To provide means of rapid confidential communication between a fleet commander and the commanding officer of a cooperating force on shore, or the commander of another fleet or division.

—Captain W. Irwing Chambers, U.S.N., in *Flying*.

*Offensive Use of Aeroplanes.*—After reviewing the progress made in avia-  
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formidable destructive power, especially against living targets, were invented in 1912. There is no doubt that aeroplanes, which have hitherto been used merely for reconnaissance, may henceforward act in an offensive capacity, or, at any rate, for destructive purposes. The future prospects thus opened for future wars are limitless. One fact is, however, clear: victory will remain with those combatants who, all other things being equal, possess not only the best but the most numerous airships."—*United Service Magazine*.

*New Steel for Armor*.—According to the Austrian papers, the Wittkowitz works have recently succeeded in constructing armor plate of steel known as electro-steel (electrostahl), which has a resistance greatly superior to steels hitherto employed. This resistance is obtained by means of electric furnaces which make it possible to regulate very accurately the degree of heat supplied.—*Revue Maritime*.

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## NOTICES

### MILITARY INVENTIONS

#### RECENT U. S. PATENTS OF MILITARY INTEREST

A complete copy of any patent here listed may be obtained of H. B. Willson & Co., Patent Attorneys, 715 Eighth St., N. W., Washington, D. C. Enquirers should indicate patent number and remit ten cents.

#### AERONAUTICS

- 1,060,200 Centrifugal Aerocycle, Robt. J. McLaughlin, New York, N. Y.
- 1,061,701 Controlling Device for Flying Machines, Paul Stumpf and Josef Schroeder, Berlin, Germany.

#### PROJECTILES, ETC.

- 1,061,887 Combination Fuse For Universal Projectiles, Karl Voller, Dusseldorf, Germany.
- 1,059,403 Armor Piercing Projectile, Alfred J. Soden, Newark, N. J., Assignor to Crucible Steel Co. of America, Pittsburg, Pa.

#### SHIPS (NAVAL), ARMOR, ETC.

- 1,057,223 Visual Signal for Submarines, Sloan Danenhower, Bridgeport, Conn.
- 1,059,475 Submarine or Submersible Boat, Cesare Laurenti, Spezia, Italy.
- 1,061,088 Rudders for the Submersion and The Navigation of Submarine Vessels Under Water, Cesare Lanrenti, Spezia, Italy.

#### SIGHTS, ETC.

- 1,057,518 Apparatus for Aiming Guns at Night, George Archer, Chicago, Ill.

## SMALL ARMS, TARGETS, ETC.

- 1,058,563 Grenade-Projected from Small Arms, Franz Deubler, Vienna, Austria-Hungary.  
 1,061,119 Cleaner for Firearm Barrels, Matthew W. P. Pool, Winters, Texas.  
 1,059,405 Folding Pistol, Horace M. Sprague, Denver Col., Assignor to The Simplex Arms Mfg. Co., Denver, Col.

## SUBMARINE MINES AND TORPEDOES

- 1,059,766 Torpedo, Louis S. Ross, Newtonville, Mass.  
 1,059,850 Automatic Submarine Mine, Giovanni Emanuele Elia, Paris, France.  
 1,059,851 Mooring Device for Submarine Mines, Giovanni Emanuele Elia, Paris, France.  
 1,059,852 Safety Device for Operating Submarine Mines, Giovanni Emanuele Elia, Paris, France, Assignor to Vickers Limited, London, England.  
 1,057,950 Submarine Mine, G. E. Elia, Paris, France.

## BUREAU OF MINES' PUBLICATIONS FOR FREE DISTRIBUTION

We have been asked to print the following:

## DEPARTMENT OF THE INTERIOR

## BUREAU OF MINES

## New Publications

(List 18.—April, 1913.)

*Bulletins*

Bulletin 48. Selection of explosives used in engineering and mining operations, by Clarence Hall and S. P. Howell. 1913. 50 pp., 3 pls., 7 figs.

The Bureau of Mines has copies of this publication for free distribution, but can not give more than one copy of the same bulletin to one person. Requests for all papers can not be granted without satisfactory reason. In asking for publications please order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D.C.

## BOOK REVIEWS

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**A Critical Study of German Tactics and of the New German Regulations.** By Major De Pardieu, Chief of Staff to the Military Governor of Dunquerque. Authorized translation by Captain Charles F. Martin, 3d U.S. Cavalry. Fort Leavenworth, Kansas: U.S. Cavalry Association. 5¾"x8¼". 165 pp. Cloth. 1912. Price \$1.25 postpaid.

The translator presents his work with the hope that it "will be of special value to officers of our service, not only because it presents a comprehensive résumé of the German tactical creeds, but also, and more especially, because it constantly compares the German and the French tactical methods. It shows the essential difference between the tactics of the two great military nations." It is a hope that should be realized.

Following the Russo-Japanese war the Germans undertook the task of revising their regulations. The several volumes appeared bearing dates as follows: Infantry Regulations, 1906; Field Artillery Regulations, 1907; Field Service Regulations and Heavy Artillery Regulations, 1908; Cavalry Regulations and the Firing Regulations, 1909.

While these volumes form the basis of the German system of tactics, Major De Pardieu has not limited his observations to the bare text. As he puts it, "the study of its regulations is not sufficient to gain a knowledge of an army from a tactical point of view. One must know first its habits, its traditions, its morale; its doctrines must be studied in the books of its authors of repute who represent the thought of the staff and of the different arms." The view-point of the author is broad; his quotations illustrate his points clearly; and his historical examples are well chosen.

The difference in temperament between the German and the French soldier is briefly touched on at various points in the course of Major De Pardieu's discussion. In the introduction he says of the German "he is thoroughly disciplined, he is vigorous, he is brave. Moreover at the last large maneuvers he showed admirable endurance. What he lacks most is the spirit of initiative, quick intelligence, the faculty of getting out of difficulty. Excellent when supported and when under a chief, whom he blindly obeys, he is lost as soon as he is alone or when he no longer feels himself to be led. His morale weakens, he is incapable of making resistance or of taking the initiative." If we accept this estimate as correct the question arises as to the appropriateness of certain drafts made by us on the German regulations and their special applicability to the prospective American soldier.

Major De Pardieu's discussion of the use of cavalry and artillery are particularly strong, and one is impelled to admit the justice of his criticisms. On the subject of advance guards, clearness and force are lacking and we are not inclined to accept the author's conclusions. Concerning the use of cavalry we quote the following: "The new regulations of April 3, 1909, the application of which was tried for the first time in the last grand maneuvers (1909), did not appear to have had a very happy influence. \* \* \*

"Dismounted action, so much extolled by the regulations, had become the rule of the German cavalry. As soon as a force of cavalry met the enemy

its first care was to throw forward a screen of dismounted cavalymen, then to maneuver behind it, not like cavalry but like mounted infantry. The cavalry in this maneuver forgot its rôle. It never sought to annihilate the hostile cavalry in order to assure itself the liberty of maneuvering."

Chapter 7 is devoted to a discussion of certain fundamental differences between German and French ideas on general tactics. The author displays no hesitancy in his criticisms: "The method of always hunting the hostile flank to win the decision by envelopment does not present merely those advantages which are so vaunted by the Germans; it has also some very great disadvantages which it is well to point out." Having placed on record such heresy we refer the inquirer to the author himself for reasons why he should not be burned at the stake.

In concluding, Major De Pardieu ventures the prophecy that "the multiplicity of the railroads, the employment of automobiles, the utilization of balloons and of aeroplanes now present to the general-in-chief new resources out of which a superior mind will be able to evolve methods of warfare that will revolutionize those now in use. The Russo-Japanese war might easily be the last great war carried out by means and methods of the nineteenth century."

Aside from a few trifling errors in typography and construction which should have been detected in proof-reading, the form of the work is commendable. The date of publication of the original in French can be determined only by inference. It appears to have been either 1909 or 1910. The translator states that both German and Russian translations were made immediately after its publication, showing it to have been regarded by both countries as a work of importance.



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other dangerous articles in interstate commerce. The Commission adopted, with a few modifications, the rules already approved by the Bureau of Explosives, which thus became binding upon all railroads and express companies whether members of the Bureau or not. In addition, the Bureau was officially recognized by the Commission, even to the extent of requiring approval by the former of any new explosive before authorizing its shipment.

Since 1908 Colonel Dunn has each year written a report on the work of the Bureau during the preceding twelve months. The report for the year ending December 31, 1912, is divided into nine parts, the report proper and eight appendices. The report proper contains a résumé of the work of the Bureau and tables of comparison in which is compared with the condition in previous years, the general state of the Bureau as to number of members, number of inspections made by local inspectors, amount of explosives condemned as unsafe for transportation, number of violations of the regulations discovered, etc.

Appendix No. 1 gives very complete details of all accidents reported during the year, and is illuminating as showing the result in many cases of violations of the regulations for packing, handling, and staying dangerous freight.

Appendix No. 2 is a report submitted by the Bureau of Explosives' Chemist on the various analyses and investigations conducted during the year. A brief outline of the scope and results of the investigations undertaken to ascertain the safety in transportation of various substances is given, from which an idea of the varied work carried on in the laboratory can be gained. One of the important functions of the laboratory is to determine or verify by tests, if possible, the causes of any explosions or fires in case doubt exists as to the origin thereof. In the report of these tests is found much valuable information.

Appendix No. 3 is devoted to a description of the work in the instruction of railroad employees by means of lectures, usually illustrated, in which the regulations are interpreted and explained so as to insure intelligent compliance therewith.

Appendix No. 4 contains a list of exceptional cases of rough treatment of cars containing explosives, together with photographs of cars in which the dangerous freight is shown in the actual condition in which found, boxes smashed and contents strewn about the car. These photographs demonstrate the necessity for careful compliance with the rules for bracing and staying this class of lading.

A list of practical questions used in the examination of the various classes of railroad employees with corresponding paragraphs of the regulations is given in Appendix No. 5. These questions are of great assistance in interpreting the paragraphs to which they pertain.

Appendix No. 6 consists of a report of the proceedings of a special meeting of the Bureau held at Chicago on November 18, 1912, and is of interest as showing the problems still to be solved in the transportation of explosives and other dangerous articles and the interest taken in the work of the Bureau by the railroad companies composing its membership.

Appendix No. 7 contains a list of the members of the Bureau, showing the date of admittance and, in the case of railroads, the mileage of the road. In this connection it is interesting to note that the list contains 300 railroads totaling 252,130 miles, among which are all the important roads, 11 of the American steamship companies, 3 express companies, and 39 manufacturers of powder and chemicals.

Appendix No. 8 is a list of the personnel of the Bureau giving name, capacity in which employed, and date of employment.

One of the principal tasks of the Bureau has been to educate those who are engaged in handling explosives, etc., to a sense of their responsibility and to bring home to them the result of disregarding the regulations pertaining thereto. A careful perusal of this report will call forth an appreciation of the value of the work of the Bureau and will aid in creating that interest in the subject of the transportation of explosives which is essential to the success of the Bureau.

The report has an especial interest for officers of the Army and Navy, but can be read with profit by all who are called upon to handle or ship explosives and other articles involving hazards in transportation.



**Nomography or the Graphic Representation of Formulæ.** By Captain R. K. Hezlet, Royal Artillery. Woolwich, England: The Royal Artillery Institution. 6"x9½". 54 p. 37 il. Paper. 1913. Price 2s 6d.

This pamphlet presents in clear and simple form the principles underlying the construction of nomograms.

In the course of his work the author defines the functional scale as distinguished from the equicrescent scale and shows the value of anamorphosis in this connection. The general method of construction of the nomogram from the equation to be represented is next considered. In the case of formulæ with more than three variables double and multiple alignment are illustrated; and finally the combination of a nomogram with a network is discussed.

As an elementary discussion of the subject the pamphlet is a success, the language being clear and simple and the figures numerous.

The book should prove interesting and valuable. The subject is worthy of careful study; and nomography should find wide application in meteorology, engineering, gunnery, and other sciences having everyday application in practice.

There are numerous typographical errors in the book; and these might cause confusion where the subject is new to the reader.

As a whole the value of this publication is considerable; the author's attitude is most attractive; and due credit has been given to other writers—notably M. d'Ocagne, who is generally recognized as the leading authority on this subject.



**Les Rayons ultra-violet et leurs applications (The ultra-violet rays and their uses).** By l'Institut Scientifique et Industriel. Paris: Mois Scientifique et Industriel, 8 rue Nouvelle. 6¼"x9¾". 63+16 pp. 44 il. Paper. Price 2 fr. 75.

In the introduction the object is stated to be to afford the reader a résumé of present day knowledge concerning the untra-violet rays, and especially to give precise information as to their artificial production and use. The contents are comprised in five chapters, of which the subjects are: (1)

definition and properties; (2) mercury vapor lamps and the commercial production of ultra-violet rays; (3) use of the rays in sterilization; (4) medical uses; and (5) miscellaneous uses. To the first, the third, and the fifth chapters are added useful bibliographical references.

Students of chemistry and of mercury vapor lamps will find in the book much to interest them. The artillerist will be particularly interested in the use of ultra-violet rays for the test of smokeless powders mentioned in the last chapter. The rays, it is stated, enable one to complete in a few hours reactions which, left to themselves, would require years; and it is this property which Messrs. Daniel Bertholot and H. Gaudechon have employed in testing modern smokeless powders, which are, in effect, colloids in process of slow decomposition. By exposure to the rays of a mercury vapor lamp, powder B and nitroglycerine powders have been examined; and it has been established that under the influence of the ultra-violet rays they decompose rapidly in a manner that is otherwise analogous to a natural, slow decomposition, giving off the same gases and in the same proportion. The appearance of powder B is not changed, while nitroglycerine powders change color slightly and exude drops of glycerine. Powder B is said to resist the action of the rays better than do nitroglycerine powders. Examination of the gases which the powders throw off, together with notation of the rapidity of the action, enable one to determine the powders' more or less advanced states of decomposition and, consequently, their probable periods of serviceability.



**Taschenbuch der Kriegsflootten.** 1913. By B. Weyer, Kapitänleutnant a.D. München, Germany: J. F. Lehmann's Verlag. 5"x6 $\frac{3}{4}$ ". 28+590 pp. Numerous cuts, sketches, silhouettes and plans of ships. 1913. Price, M5.

Weyer's Handbook of Navies is an excellent book for enabling one to become acquainted with the relative strength of the navies of all nations, and especially the fighting strength of each individual ship. It contains tables showing all the warships of the world, giving exact data relative to size, speed, armament and crew, so that wherever a ship is mentioned one can immediately obtain all the details relative to it. Photographic views of all types of ships follow the tables, together with exact data concerning their power. Silhouettes of characteristic types of ships enable a person to determine to which navy a ship belongs, even at great distances on the high seas. Most interesting is the comparative synopsis which follows, showing the disposition of armament on the latest ships of the line, and incidentally setting forth the fact that a complete change has taken place in the arrangement of guns.

Then follow instructive tables, such as those of the personnel of the great naval powers during 1912; their budgets from 1901 to 1912; the expenditure of the great powers for land defense during the last ten years; the naval stations of the great powers; the various grades of naval officers of the different countries; naval and coast guns by Krupp, Armstrong, Coventry, Vickers, Schneider and Co., Bethlehem Steel Co., Skoda-Werke, and Bofors, in which valuable information is concisely stated and well arranged.

In the chapter on Naval Interests, compiled by Professor Harms and Dr. Hillringhaus, is presented a vast amount of information and data arranged in a most concise form.







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## SUPPLEMENT

### Index to Current Military Literature

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## CHANGES OF ADDRESS

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Much inconvenience to subscribers and considerable loss to the JOURNAL occurs through the failure of subscribers to report changes of address.

It appears to be generally believed that the publication of the "ARMY LIST AND DIRECTORY" renders unnecessary requests for changes of address on the JOURNAL'S mailing list. But that is not the case, for the postal regulations are such that the mailing list must be arranged *geographically*. So, in order to enter the mailing list for the purpose of making changes, old addresses are necessary. Consequently, changes can conveniently be made only when requests from subscribers or irregularities of service *bring to attention both the old and the new addresses*.

There is also some question as to whether the JOURNAL'S management, when it learns indirectly of a change in a subscriber's official address, is justified in changing his mailing list address: the two are not necessarily the same.

Your cooperation in economical and satisfactory service is, therefore, solicited.

*In reporting changes of address please give both the old and the new.*

de Raude, which is only some 600 yards across, and then, inside this narrow passage, the water broadens into a sort of a lake. . . .

"What may be called the entrance to the Bay of Vigo is about one-and three-quarter miles across, and at the time I write of, there do not appear to have been any batteries or fort there.

"The town of Vigo was itself defended by some works, but they were not of any magnitude, and did not affect Sir G. Rooke's proceedings in any way."

Chateau Renault had drawn the whole of his ships and their convoy through the Estrecho de Raude, and forts and batteries had been erected on each side of the strait at its narrowest part; the works on the south side mounting 38 and on the north 17 guns.

A boom connected the two forts, and obstructed the passage, and far within the boom the French fleet was anchored in the form of a half moon, intended to protect the galleons.

On the 10th October Sir G. Rooke's fleet passed up the bay.

It was fired on by the forts of Vigo in passing, but without effect, and it anchored above the town to observe the situation, and mature the plan.

It was decided in the first place to land sufficient force to capture the batteries on the south side, and that when the English flag should be hoisted as a sign of the works having changed hands, 25 of the ships should proceed to break the boom, and pass on to attack the French.

The Duke of Ormonde landed at 10 a.m. with 2000 or 3000 men. The book from which Colomb quotes\* makes it clear that the fortifications were merely temporary trenches, and batteries, presenting no obstacle to a rush, and that there was no real garrison, the defenders being landed from the ships.

"We had no sooner took the platform, on which were 38 cannon, but the detached ships which were drawn up in line of battle began to sail. Admiral Hopson with undaunted courage leading the van, and forced the boom with his ships.

"The only casualties in the fleet were inconsiderable, with the exception of those on Admiral Hopson's ship, which was clapt on board by a French fire ship and lost in the action, being killed and drowned, upwards of 100 men.

"Our loss on shore was two officers killed and four wounded, and about 10 private men killed and as many wounded.

"This glorious victory was obtained in about two hours time.

"There were inside the boom 18 French and three Spanish men of war, most of them being line of battle ships; and they were intended to protect 13 rich Spanish galleons carrying from 20 to 30 guns each.

"The result of the attack was that everything that floated inside the boom was either burnt, sunk, or captured.

"Six French ships and five galleons were taken, eight French ships burnt, and four French ships were sunk, the remainder were either burnt or sunk."

It is, perhaps, one of the most remarkable failures of a fortified port to protect a fleet which had sought its shelter.

From the passage quoted it would appear that the ships had disembarked men and stores for the land defense of the entrance, and must therefore have considered the position so arranged more secure than it would have been had they kept their ships in the outer harbor, in order to meet the enemy broadside to broadside there, placing only the galleons in the inner lake, where it might be trusted that they would be out of harm's way.

\* "An Impartial Account," etc., pages 21-25.

Modern science cannot be said to have greatly advanced on the method of land defenses adopted by Chateau Renault. But then, probably, modern science could not better the method of attack decided on by Sir G. Rooke.

As I drew my narrative from Colomb it seemed only right to also quote comments on the action.

How the position taken up by the French fleet can have appeared to him to merit the title of a fortified port I cannot explain—but a few guns, mounted on temporary platforms, and guarded against land attack by nothing better than hasty field entrenchments, did not constitute a coast fortress, in those days at any rate.

To those who may think that I am treating a battery mounting 20 guns rather lightly by alluding to its armament as a few guns, I would point out that they could not have possessed the tactical advantage of similar artillery sited in permanent works, and were therefore called on to engage a line of battle ship's broadside on practically equal terms, even if they were of equal caliber.

This latter point is at least doubtful, as the time limit makes it improbable than anything heavier than upper deck guns were landed from the fleet.

Colomb suggests that political intrigue may have had a good deal to do with the failure of the attack on Cadiz, and it may well have been so, but in that case the same cause may equally well explain the surrender of Rota and Sta. Catalina.

My object is to bring out the fact that, against the same force, the permanent works of Matajorda remained intact after a fortnight's siege operations; whereas two hours sufficed to overwhelm the extemporized defenses at Vigo Bay.

#### THE BRITISH ASPECT OF THE QUESTION

One more aspect of the question remains to be dealt with, viz., the value of fortifications to our own ultimate naval bases.

Perhaps this is the most vital question of all, as any miscalculation in this respect would mean, not loss of maritime preponderance in some sphere where it might eventually be regained, but an absolute collapse of further resistance and practically the ruin of the Empire.

To make my argument clear I must first inflict on you the particular doctrine I am trying to controvert.

Colomb, in reviewing the results of the campaign of 1744, 1759, 1779, and 1805, remarks,

"In no case, through all these series of operations, can we bring our fortifications into relation with our fleets at all in the home waters. On the other hand, there were always the closest relations between the French fleets and the fortifications under which they sheltered themselves. Our admirals never thought about their bases being fortified, being fully persuaded that they were themselves their defense. And the mere fact that the open anchorages of Cawsand Bay, Torbay, St. Helens, and the Downs, were their *points d'appui*, accounts for the absence of all expressions of doubt as to the support which might be afforded by the shore."

As regards the Maritime War, 1779-82, Great Britain was inferior to and Mahan blames their commanders for not  
Torbay to action.

see, in this instance at least, that the British





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Attack Shu

The edi of the Journal of the United States Artillery, for July-August, 1906, Whole  
No 50, conti an article on Armor and Ships, having been exhausted and there being  
400 1 for 2000 1 copies, it was decided to prepare and issue a revised edition of the  
in the form a pamphlet in two parts; Part I dealing with Armor and Armor Attack.  
II: with hips, and Attack of Warships. The work has been completely  
revised. I has been used during the past four years in the Coast Artillery  
of s and additions are the result of suggestions from Student  
jury at con.

**Journal of the U. S. Artillery,**

Fort Monroe, Va.

There flotilla encountered flotilla. Usually the Russians were forced to retire, and it was the guns of the fortress which checked the pursuit.

It is not a very large step to assume that in the future all kinds of light craft, including submarines, made use of by the defense, will be encountered by the action of similar vessels.

The theatre of operations, the sea, common to both sides, affords no advantage to either. The defense in this case has no inherent superiority such as the fixed armament possesses in the case of an artillery duel with the attacking squadron.

We here see the weakness of local floating defense.

The assailant, choosing his objective, can concentrate a force superior to that which can be provided for the defense without an absurdly lavish expenditure; especially when, as in our case, there are a large number of strategically vital points in all parts of the world to consider.

If a naval base is attacked we may assume that the assailants will have a numerical superiority in these craft; and, in that case, those of the defense will be driven in; if the fortress is without guns the assailants' artillery will complete the victory.

Whereas, if the menace of the fixed armament remains, the enemies' capital ships cannot close, and their light craft cannot follow up their success. The waters thus preserved are specially important as they prevent the mobile defense being bottled up.

The submarine and destroyer have their parallel in land warfare; they correspond to the light troops thrown out in front of an army in position, or a fortified town; they prevent any advantage being gained by any action short of an attack in force, and yet they could not maintain their position without the support of the main body.

Mines are obstacles, and their utility is governed by the general rules affecting obstacles. They are only of use when protected by effective fire.

Countermining and sweeping vessels will soon clear away these dangers unless approach is rendered practically impossible by the fixed armament.

It is with reluctance that I bring my labors to a close. It is not for lack of other, and perhaps even better, examples, but I think enough credible witnesses have been cited to prove my case to an impartial mind. Those who remain unconvinced of the utility of fortified bases, must elect to ignore the unwavering policy of those strategists who built up England's sea power.

I can only compare them to the rich man, who thinks lightly of money because he has never known the want of it.

—*Journal of the Royal United Service Institution.*



## RECENT DEVELOPMENTS IN BATTLESHIP TYPE\*

BY ALAN H. BURGOYNE, M.P., M.I.N.A.

The subject of this paper has frequently provided the basis of discussion at meetings of the Institution of Naval Architects, yet it recurs with never-ending freshness, for, though the basic principle of ship-type remains largely

\* Read before the Institute of Naval Architects.



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- (2) The acceptance of this tendency to increase in big gun caliber, weight of shell, muzzle velocity, and striking energy, an increased ratio of defense was essential to maintain battle-worthiness.
- (3) The necessity of a greater weight of armor, of concentration of force in the main guns (probably in the direction of increased numbers as well as increased caliber) required higher displacements.
- (4) The proper disposition of a large number of main guns, to avoid "interference," called for increased length.
- (5) The practicability of turbine propulsion for the mightiest units suggested, in its sensible application, an advance in the hitherto accepted standard in battleship speed.

With these five requirements as a ground-work, five main designs (there may have been others) are known to have been evolved:—

- (A) The *Dreadnought* in Great Britian.
- (B) The *Satsuma* in Japan.
- (C) The *Michigan* in the United States.
- (D) The German Admiralty design, subsequently abandoned for the *Nassau* class.
- (E) The forecasts of General Cuniberti in Italy.

In each case a hesitancy to go the whole way was clearly evidenced; it is easy to be wise after the event, but it is fair to assume that with even a single year more of study of the problems, each design set up would have led to their abandonment as not fitted to the practical needs of the time. Thus, in (A), the claims of the anti-torpedo-craft armament were almost entirely ignored; in (B) the desire not to abandon old ideas too quickly is easily apparent; whilst (C), with the fault of (A) strongly present, retained (as did all from (B) to (E) ) the disadvantages of a relatively obsolescent mode of propulsion. (D) and (E) never materialized and for exactly opposite reasons. The German design was out-distanced at its inception, the Italian suggestion leapt ahead of invention and progress, and therefore remains a striking testimony to the prophetic genius of its author. A little national pride may be pardoned me if I submit that, of the five, the *Dreadnought* was undoubtedly the most practicable compromise of them all.

In the following table no attempt is made to give detail; the particulars are only for the purpose of outlining "type."

	(A)	(B)	(C)	(D)	(E)*
Displacement	17,900 tons	19,350 tons	16,000 tons	16,500 tons	17,000 tons
Engines.....	Turbine	Recipro- cating	Recipro- cating	Recipro- cating	Recipro- cating
Designed Speed	21 knots	20 knots	18½ knots	18 knots	24 knots
Belt Maximum	11 in.	9 in.	11 in.	11 in.	12 in.
Main Guns	10 12-in.	{ 4 12-in. 10 10-in.	8 12-in.	6 11-in.	12 12-in.
Anti-Torpedo- Craft Armament	{ — 27 3-in. Q.†	12 6-in. Q. 12 smaller Q.	— 22 3-in. Q.	12 6.7-in. Q. 20 3.4-in. Q.	— 12 3-in. Q.

With the acceptance of these ideas as formulating "type" came this further consideration—how best to utilize the value of each gun carried?

Cuniberti's ship, despite her numerically superior armament, would,

\* Jane's "Fighting Ships."  
† Original Armament.



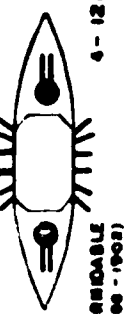
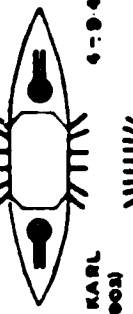
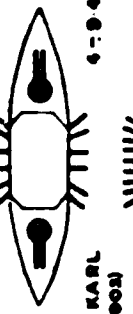
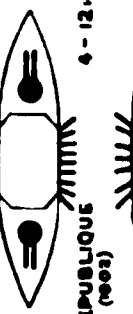
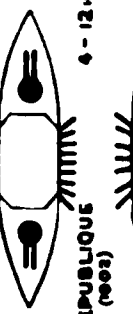
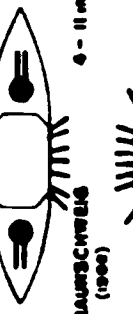
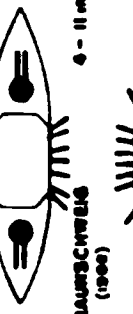
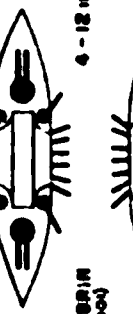
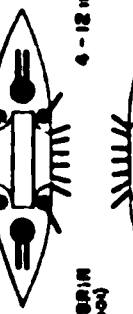




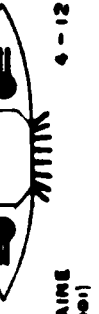
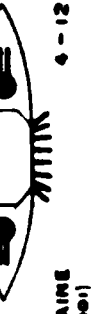
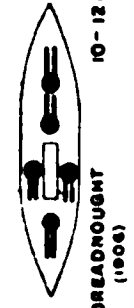



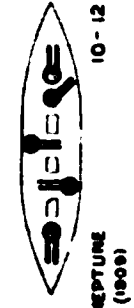
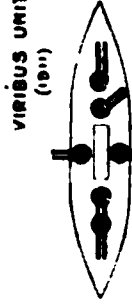

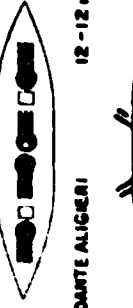
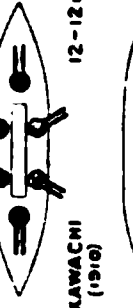


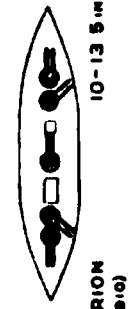
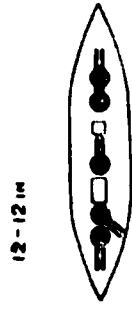
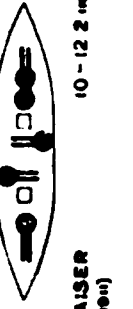



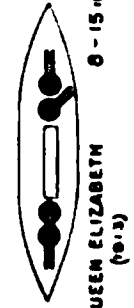
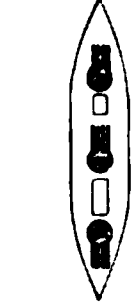
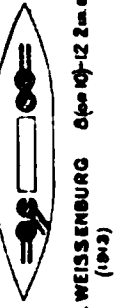
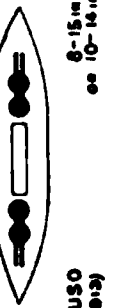


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	CZAREVITCH (1904) 4-12 in.									
RUSSIA										
	CZAREVITCH (1904) 4-12 in.									
										
	MAINE (1901) 4-12 in.									
U. S. AMERICA										
	MAINE (1901) 4-12 in.									
	1902-4									
1st STAGE										
										
DREADNUGHT (1904) 10-12 in.										
										
VIRIBUS UNITIS (1911) 12-12 in.										
										
NASSAU (1904) 12-11 in.										
										
MICHIGAN (1904) 6-12 in.										
2nd STAGE										
										
NEPTUNE (1900) 10-12 in.										
										
VIRIBUS UNITIS (1911) 12-12 in.										
										
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OSTFRIESLAND (1909) 12-12.2 in.										
										
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PROVENCE (1913) 10-13.4 in.										
										
KAISER (1911) 10-12.2 in.										
										
CONTE DI CAVOUR (1911) 13-12 in.										
										
I. ALEXANDER III (1913) 12-12 in.										
										
TEXAS (1912) 10-14 in.										
4th STAGE										
										
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TABLE ILLUSTRATING MAIN ARMAMENT DISPOSITION IN BATTLESHIPS OF THE EIGHT CHIEF NAVAL POWERS 1279

Notes:—Dates of launch are given in brackets under the names of type. The plans between the stages of development indicate vessels of an intermediate type. Except in the first column, the main armament only is shown

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Their results apparently are not sufficiently effective, for it is stated a heavier piece, a 16.5-inch mortar, which is probably designed for the coast, and of which two test pieces have already been delivered, will be experimented with. As the maximum range is about 15,300 yards, the proof firing will not be held in Felixdorf, but on the new large proving grounds at Hajmaske. The weight of the projectile is said to be about 2200 lbs.

—*Deutsches Offizierblatt*. \*



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The advance from slow fire to rapid fire—an advance made possible for field guns by the employment of recoil carriages and fixed ammunition—could not, of course, be limited to flat trajectory pieces, so curved fire pieces,

*d*

in their turn, are now experiencing a like evolution. But while it is simple enough to apply to howitzers the principle of the long-recoil carriage, the adoption of fixed ammunition for them is rendered difficult by the necessity,

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“In general, it is fundamentally wrong, if as the English now appear to do, one places his hopes all too much on a presumptive advantage in the perfection of the technical aids, so easily injured in battle.

“On the other hand it would of course be wrong if one ceased endeavors to try all technical innovations as to their usefulness.”

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### BRITISH NAVAL GUNNERY

It is a significant fact that in the returns issued this week by the Admiralty giving the results of tests of gun-layers in the Fleet for the past year there is no reference to the time element. Formerly the number of hits per minute by the twin-gun turrets of capital ships and by guns in the case of smaller caliber weapons was an important, if not the determining, standard of efficiency. But now the factor indicative of excellence is the percentage of hits to rounds fired. Is this a consequence of the new system of gun-control under which salvo firing is preferred to independent fire and central gun-laying to aiming being the individual work of the captain of the turret or of the gun team? The difference is one of significance whether regard be had to the much-debated question as to whether the function is to disarm or to destroy the enemy, although it must be admitted that the latter is much more likely to be achieved by a well-directed full broadside rather than by a rain of shots independently fired. With the increase in caliber of guns, the consequent additional weight of ammunition for a given number of rounds, and the resultant limited duration of an engagement, the efficiency of each shot has had to be most carefully considered, and consequently central gun-laying has won the day.

In analyzing the results of the past year's work, the chief consideration must be the percentage of hits to the number of rounds fired. The 13.5-in. gun comes into the return for the first time, four ships having used this weapon in battle practice—the *Orion*, *Lion*, *Monarch*, and *Thunderer*—and the percentage in the case of these ships, according to the order given, is about 68, 65, 53, and 47½, the average for the 126 rounds fired being 58.



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